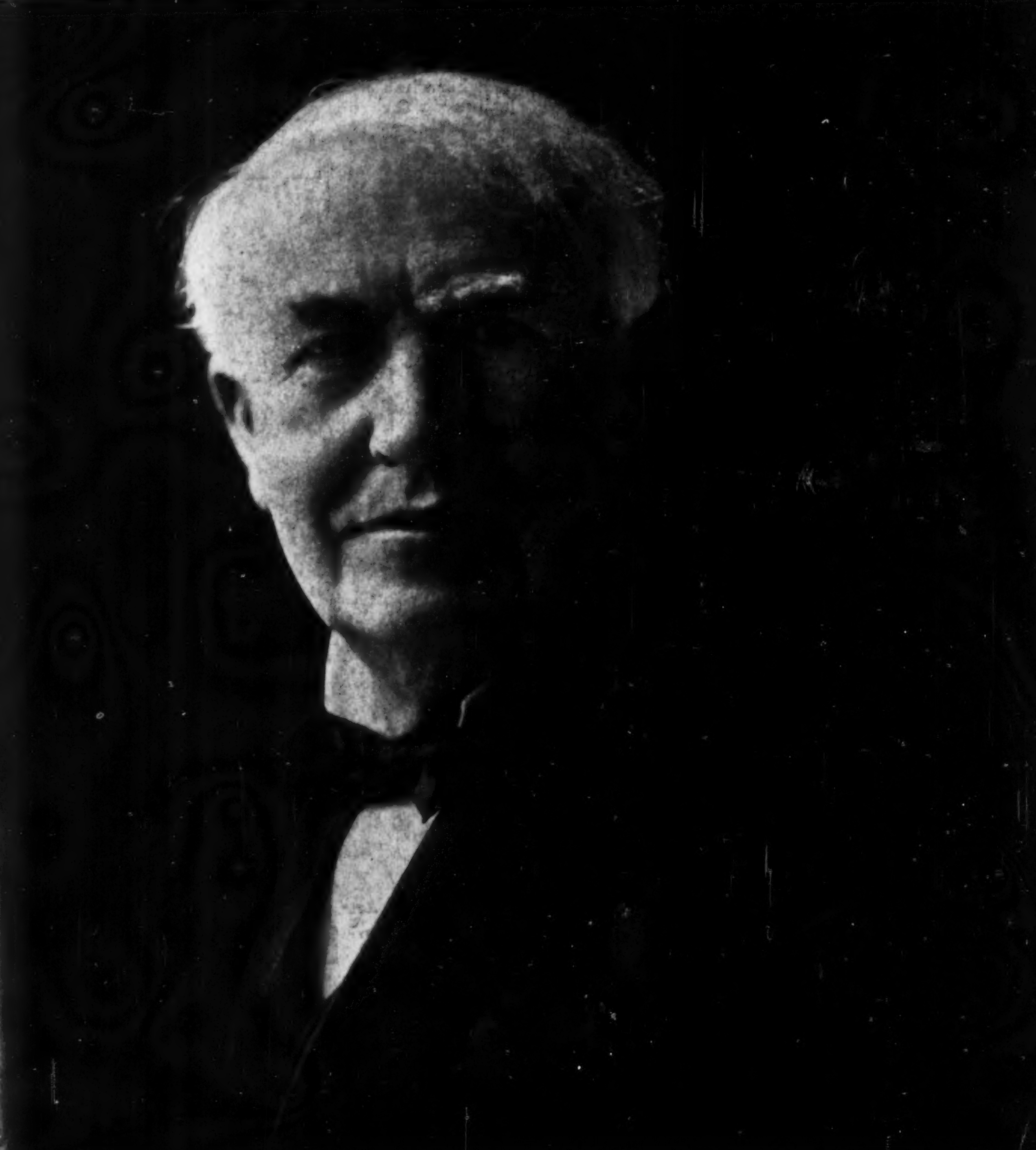
MECHANICAL ENGINEERING



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Edison and Tin-Foil Phonograph Exhibited in White House, April, 1878

Volume 69
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MECHANICAL ENGINEERING

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GEORGE A. STETSON, *Editor*

Edison Centennial

IT is fitting that mechanical engineers should take note of the one-hundredth anniversary of the birth of Thomas A. Edison for there are few enterprises in which they are engaged today that have not benefited materially from the contributions of that great inventor. The American Society of Mechanical Engineers in particular will find in the Edison Centennial a confirmation of its foresight in making him an honorary member in 1904 and thus becoming the first of many scientific and engineering societies to recognize his achievements in this manner. Members of the Society will also recall with satisfaction that Edison, as a co-author with Charles T. Porter, presented a paper at a meeting of the Society in 1882 in which the steam-engine belt-driven dynamos used for electric lighting in New York City were described.

It would be fruitless to attempt to assess the accomplishments of Edison from which mechanical engineers derived benefit. Even a list of them would be long. Sole or major credit is due Edison for many inventions that opened up new fields of engineering and industrial enterprise and hosts of others lay in areas where improvements on existing methods or devices shed additional luster to an already brilliant record.

Few Americans have become so well and so favorably known to the public as Edison. For years his name symbolized the inventor who could produce the most sensational and improbable results. He lived in an age when invention and development were not the necessary elements of business and industrial enterprise to the extent that they are today. Men like Edison supplemented the flash of genius, which had long been the public conception of invention, by hard and purposeful work, and devised techniques by which their efforts were organized to bear fruit. No problem was too fantastic, no obstacles too difficult to dismay or discourage them. By constant training of their powers of observation and analysis to discover the elements which were needed for the necessary steps toward predetermined objectives, they acquired the faculty of seizing upon significant by-products of their studies and utilizing them to attain different and additional objectives. No fact was too remote from the business in hand not to be suggestive of something new that might be important.

One who knew Edison intimately has said that none of the biographies adequately reveal Edison the Man. Stories of the successful achievements of an inventor do not necessarily reveal the man himself. Perhaps no biographer can ever do that or even successfully discover what qualities of mind, spirit, and body were combined by nature to produce his genius. What means are there by which imponderable and apparently irrelevant qualities may be assayed in an effort to determine their significance in the success of a man's work or their influence on the vital energy by which he was compelled to prosecute it? Were the true analysis of these factors to be presented to us, would we comprehend its significance, admit its validity, or profit by its lesson? In the case of every great man this attempt is made and who is there that can do more than decide for himself whether or not truth has been bared? But every one of us, engineers particularly, pay tribute, and can take satisfaction in the fact that such men as Edison have lived among us and have left behind them a better world.

Using Ideas

IT has long been the editorial policy of this magazine to effect a cross-fertilization of ideas. The opportunities to exercise this function are numerous. The field of mechanical engineering is broad and those who practice in it must inevitably concentrate on a relatively few specialties. But, as even the briefest reflection will prove, the development of a specialty is constantly enriched by ideas which originate in other and, in many cases, quite remote fields. The sciences themselves are undoubtedly the most common source of the enrichment that the development of a specialized field of engineering enjoys. Quite as important, however, is the enrichment which comes from collateral engineering fields. An alert engineer, no matter what his function—research, development, design, or production—is constantly borrowing ideas from other sources and adapting them to his own needs. If his contacts are broad and his imagination is an active one, his own work progresses rapidly and acquires greater value. An engineering magazine which does not devote itself to a narrow field of intense specialization is one means by which an engineer's contacts are enlarged. All that such a magazine can do toward helping the engineer to make best use of the material it brings to his attention is to attempt to stimulate his imagination. What significance to his own work this material has and how successfully he puts it to his own uses are his own responsibility.

The foregoing comments have been called forth by an article by Dr. Paul M. Fitts, "Psychology in Aircraft Design," in this issue, which originated at the time the

article was presented as a paper at the 1946 A.S.M.E. Fall Meeting, held in Boston in the fall of 1946. On that occasion, in adjoining rooms, two A.S.M.E. groups were holding technical sessions—the Aviation Division, at which Dr. Fitts's paper was presented, and the Machine Design Group. Aside from the single word "design" which appears in the title of Dr. Fitts's article, there was nothing to attract an engineer interested in machine design. Yet, as the substance of Dr. Fitts's paper was unfolded, the conviction grew in the mind of at least one observer that the doors should have been thrown open into the adjoining room so that the engineers who had come to Boston to learn about machine design could have had their imaginations stimulated by listening to the psychologist and his report of experiments on reading instrument dials and selecting control levers by position and "feel."

When an aviator misreads an altitude meter and thinks he has 1500 ft between his plane and the ground instead of 500 ft, or when he pulls up his landing gear when he thinks he is actuating the flaps, serious consequences may and do result. Airplane designers, aided by psychologists, are striving to minimize errors that are the result of misreading instruments and pulling the wrong lever, as Dr. Fitts's article reports. In the shop, danger to the operator's life is less likely to result when similar errors are made than is the case with an airplane pilot. Perhaps loss of time or spoiled work is the most that can be expected in the shop. To an alert machine designer, however, the work of Dr. Fitts and his associates should be suggestive of ways in which easy-to-read dials and scales and easy-to-distinguish control levers, placed with a view to eliminate errors of selection and for the maximum convenience of the operator, can be developed.

The implications of Dr. Fitts's article as an example of how cross-fertilization of ideas may be effected are set forth in its opening paragraphs, as follows:

"Engineers," he says, "have usually been concerned with the design and manufacture of equipment, and psychologists with such problems as the selection and training of men to operate equipment after it is produced. However, there is a growing belief that it is often much more efficient to design machines initially in relation to human capacities and limitations than to select and train men to use machines many of which may not be adapted to human abilities.

"Engineers, of course, are aware that most equipment is intended for human use, and often give serious consideration to human requirements. However, no convenient body of scientific fact is now available which can be referred to by an engineer who wants to predict how well the equipment that he is designing will be adapted to the psychological capacities and human limitations of the user. Psychologists, on the other hand, have collected a large amount of data regarding human aptitudes and capacities, but have made little effort to study the problems of equipment design, or to report psychological data so that they can be used by engineers."

Dr. Fitts's article is an attempt to bridge the gap between engineers and psychologists to which the preceding paragraph calls attention. Useful as the work he has done may be in solving the special problems of airplane design toward which it was directed, it is equally useful in stimulating others to apply these techniques to their own work with the result of more extensive cross-fertilization of ideas from one field into another.

Collins P. Bliss

COLLINS P. BLISS, whose death occurred on December 27, had a long and distinguished career at New York University. As head of the Department of Mechanical Engineering and later as dean of the College of Engineering his energy and enthusiasm were devoted to the improvement of that institution and its relations with the public. Much of the growth of the plant and equipment at University Heights during recent decades was either the result of his efforts or was powerfully influenced by him, for he had the quality of arousing the interests of others with a desire to assist in forwarding his plans and projects.

Dean Bliss liked people. He discovered and developed the best qualities in everyone he met. It would be surprising to learn that he had ever uttered harsh criticism of any one. He had neither guile nor hypocrisy in his nature, and his actions and conduct were the same on all occasions, whether business or social, for the genuineness of his character would not permit him to play two parts. These human qualities made him an ideal committee chairman, a fact which The American Society of Mechanical Engineers discovered and used to advantage.

Dean Bliss, a graduate of Princeton University where he received the B.A. and M.A. degrees, started his work at New York University in 1893. He threw himself wholeheartedly into the activities of academic life and became a leader in that community of college people which grew up around the University at University Heights overlooking the Harlem River. His creative and constructive zeal extended to nonacademic fields. Whenever a new building was added to the plant at the Heights, Dean Bliss was in the thick of the planning and fund raising. His efforts to establish a school of aeronautics resulted in interesting the late Daniel Guggenheim to donate to the University the Daniel Guggenheim School of Aeronautics, which was followed by the construction of many other laboratories in universities throughout the nation with Guggenheim funds. A more recent engineering laboratory at the Heights bears Bliss's name.

A member of A.S.M.E. since 1903, a Fellow since 1941, Dean Bliss had a long period of service on A.S.M.E. standardization committees. He was president of Engineering Index, Inc., a post which required faith and enthusiasm to assume. He served as a Trustee of Robert College, Turkey, where his son occupies the position of dean of engineering. His energy, enthusuasm, and leadership will be missed in all of these institutions.

PRICING POLICIES *and* SOCIAL TRENDS

By HAROLD G. MOULTON

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ECONOMIC progress depends basically upon the combined influence of the following factors: (1) Natural and human resources; (2) scientific discoveries and inventions; (3) engineering applications; (4) business organization and management; (5) the economic system; and (6) the governmental system. Scientists, inventors, engineers, business managers, and professional students of economics and government are, in the final analysis, co-operating in a common objective, namely, that of increasing the capacity of the people to satisfy their wants.

Each of these groups naturally likes to think of itself as of primary importance; but the sanest conception is that each is an essential part of a larger whole. Scientific discoveries would not yield practical results if we did not have invention; patented technological apparatus and devices would be impotent were it not for engineering applications to productive processes; engineering can function in a private-enterprise system only in conjunction with a business organization which appraises the feasibility of new developments in relation to other factors of production and the potentialities of profit and loss; the individual business enterprise in turn will be thwarted if the economic system is defective; and, finally, the functioning of the economic system is dependent upon the character and the administration of the governmental system.

As a result of a combination of developments, which cannot here be summarized, these various factors came to work together so effectively as to give us a century or more of phenomenal progress. As we look forward, continued advancement will depend upon the degree to which we can continue to make these interrelated parts of a complex society work effectively together.

The economic and political conditions of recent decades have been a challenge to the thinking of engineers and economists alike. The realization of the possibilities inherent in scientific discoveries and engineering application has been seriously impeded. The engineering profession has been in no small degree thwarted. However, with characteristic American spirit of determination, the profession seeks to comprehend more fully the conditions upon which economic progress, and hence the realization of engineering potentialities, depends.

THE CLASSICAL CONCEPTION OF THE ROAD TO PROGRESS

The fundamental requirements for the successful operation of a capitalistic system may be stated as follows: Back of each new unit of productive power there must be placed a corresponding unit of consuming power. The economies of mass production cannot be realized unless we have corresponding mass consumption. In any nation the ultimate stimulus for economic expansion is found in the unfulfilled desires of its population. The realization of these desires depends upon buying power as expressed in the relationship between wages and prices.

As a preliminary to a discussion of recent trends, it is desirable to recall briefly the basic principles upon which the capitalistic system, historically speaking, depended for its successful operation. These principles were not only long ago set forth in economic literature, but they have also long been embedded in the thinking of engineers and businessmen. They sometimes tend, however, to be forgotten amid the pressures of everyday practical affairs.

The general theory underlying the system of capitalistic production and distribution clearly recognized the necessity of an ever-expanding mass purchasing power in order to absorb the expanding capacity of productive establishments. It was believed, moreover, that the competitive system would automatically bring about the desired results:

1 It was observed that under a system operated for private profit each business manager naturally seeks to reduce costs by increasing the efficiency of production. He may accomplish this by the construction of a larger and more efficient plant, by the installation of improved equipment, by the introduction of superior internal management, by improved methods of marketing, by integrating various stages in the productive process, or by a combination of these methods.

2 Having reduced costs of production, he is in a position to increase his profits in one or another of two ways. He may continue to sell at the same price as before, enjoying the advantage of a wider margin between cost and selling price; or he may expand the volume of his business by means of price concessions. It was reasoned that since the increase in efficiency which is responsible for the reduction in costs commonly involves an expansion of productive capacity, and since the maximum economies can be obtained when operating at full capacity, the greatest profits will result if the output is expanded by means of a reduction of prices. The wise alternative is to expand sales by offering the products at a lower price.

In short, increased efficiency makes possible lower prices, while the profit incentive insures the actual reduction of prices. The greatest profit to the business enterprise is thus derived through giving to the masses the most for their money. The interest of the profit maker, therefore, coincides with the welfare of the community.

3 The process naturally involves the continuous elimination of obsolescent or otherwise inefficient, high-cost, or marginal establishments. The fit, as gaged by ability to sell at a minimum price, alone survive; moreover, the efficient of today promptly become the inefficient of tomorrow. A particular businessman, firm, or corporation may indeed survive over a long period of years, but only if the production methods employed keep always abreast of changing times.

I submit that these fundamental requirements for progress under the capitalistic system have never been challenged. I submit that they cannot be refuted. As we increase productive

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efficiency we must, if our productive resources are to be fruitfully employed, match it with increased consumptive power among the masses.

This classical line of analysis, it will be observed, emphasized falling prices rather than increasing wages as the means by which buying power would be increased. It was assumed that wage rates would be maintained—possibly increased—under the operation of the forces of supply and demand; but progressive price reductions resulting from competition were regarded as the chief means by which the benefits of technological progress would be disseminated.

WAGE INCREASES VERSUS PRICE REDUCTIONS

Standards of living may of course be increased either by reducing prices or by increasing wages, the essential requirement being an improving ratio between wages and prices. Over the past century the enormous improvement in living standards has, in fact, been brought about by a progressive improvement in the wage-price ratio. The facts show that sometimes the improvement has resulted from increasing money wages, and at other times from falling prices. Indeed, it has sometimes occurred when both wages and prices were rising, but with prices advancing less rapidly than wage rates.

The method which appears as natural to labor is that of increasing wage rates. Higher money wages can be visualized as more dollars in the hand. A corresponding improvement by means of lower prices is less tangible. For psychological reasons it is harder to comprehend; to the average man it is an elusive concept. Accordingly, throughout modern times the efforts of the laboring population have been devoted to securing higher standards of living through the medium of higher wage rates.

The Brookings Institution's studies of the impact of wage and price changes upon the economy as a whole lead to the conclusion that the wage-increase method is at best uneven in its operation and restricted in its effects. When, as a result of technological progress in any given line of industry, wage rates are increased, the immediate benefits are confined to the particular group of workers involved; they are not extended to the consuming public generally. Even if there were a more or less general increase in productive efficiency in manufacturing industry as a whole, the benefits would, immediately speaking, be confined to the laborers in the manufacturing industries. The buying power of other labor groups, of the farm population, and of the professional and public-service groups would not be directly affected. Only by gradual processes could the benefits be broadly distributed throughout the economic system.

Moreover, the increase of money wages tends to create a basic maladjustment between two great divisions of our economic life and thus to impose a serious barrier to economic progress. The struggle to obtain higher living standards through the medium of higher money wages has been the cause of a long and deep-seated conflict between the agricultural and urban populations. The people of the cities have fought for higher wages even though it has meant somewhat higher prices for industrial products. The farmers have long fought for lower prices for the industrial products which they buy. The struggle underlies the so-called granger movement of the seventies; it explains the traditional opposition of the agricultural South to high protective tariffs; and it lies at the basis of farmer opposition to trusts, monopolies, and combinations in all their forms. It explains, finally, the recent agricultural program of restricting output as a means of restoring "price parity" between agriculture and industry.

Finally, the wage-increase method is less likely than the price-reduction method to be properly articulated with accompanying changes in productive efficiency. Constantly increasing productivity, as we have seen, is the underlying requirement. But, in the world of practical affairs, labor naturally seeks to improve its position by the bargaining process at times when there has been no permissive increase in productivity. Especially in recent years, when wage advances spread as by a sort of contagion throughout the entire economic system, serious repercussions frequently occur. It may be possible to grant increases in wage rates in industry A, but not in industry B; or in manufacturing industry as a whole, but not in transportation or mining. In consequence, offsetting price advances are often necessary, which may touch off a rising spiral of wages, prices, and again wages.

In contrast, when prices are reduced (without a reduction of wages) the benefits automatically accrue to the entire population. That is to say, it not only adds to the purchasing power of the labor group, but it increases the real income of the non-wage urban population and of the farm population as well. Since the benefits are distributed throughout the entire economic system, a better balance is maintained between the different divisions of our economic life.

In short, the broad highway along which economic progress should be sought is the avenue of price reductions. When this road is followed, the benefits of technological improvements are automatically conferred upon all divisions of the population. Maximum expansion of purchasing power is obtained and equilibrium is maintained.

RECENT TRENDS IN WAGE-PRICE RELATIONSHIPS

There has been a general tendency in recent years to transfer all of the benefits of technological progress to labor by means of the pay envelope. Indeed, there has been a tendency to grant wage increases in anticipation of technological advance. Sometimes this policy is rationalized as a desirable spur to industry to increase its efficiency. The common result, however, is rising prices, which defeats, at least in substantial measure, labor's own objective.

A brief review of wage and price relationships in recent years is essential to a clarification of the problem before us. During the summer of 1933 wage rates were sharply increased as a result of the N.R.A. code agreements. Prices advanced quickly but not quite proportionately. Then from early 1934, until the third quarter of 1936, wage rates continued to increase at a moderate pace, while the prices of manufactured goods remained practically stable. During this period, productive efficiency was materially increased, in fact, in rough proportion to the increase in wage rates.

However, in late 1936 and 1937 an unbalanced situation developed. There was a very sharp advance in money wages; hourly earnings increasing between the third quarter of 1936 and the second quarter of 1937 by approximately 16 per cent. This was a considerably greater advance than had occurred during the preceding three years. Moreover, unlike the preceding gradual increase in wages, the sharp advances of 1937 were wholly unrelated to efficiency. In consequence, advances in prices became necessary if profits were to be maintained. The wholesale prices of manufactured products rose during the same period approximately 6 per cent; considerably less than one half the advance in money wages. However, thanks to the expanding volume of output, profits in manufacturing industry were well maintained.

In the railroad field the story was very different. While wage rates were not immediately raised, the higher costs of materials immediately affected profits. Railroad earnings dropped nearly one third in the second quarter of 1937, and this decline led to a sharp curtailment of railroad purchases in the summer of 1937.

In a similar way, rapidly rising wage and material costs pinched the housing industry and arrested the vitally needed expansion which was just beginning to get under way in this long-neglected field. Despite the great need for housing, rents had been rising but slowly; hence with the advance in building material prices and wages, the emerging profit margin was again reduced and building commitments again lagged.

The underlying factors responsible for checking the expansion movement of 1936–1937, can thus be very definitely traced. Sharply rising costs, which in certain basic industries could not be absorbed either by increased efficiency or by means of higher prices, inevitably resulted in economic maladjustment, curtailment of business, stock-market reaction, and the downward spiral of depression.

The lesson of this period is that rapidly increasing wage rates may bring depression even though purchasing power remains adequate. In fact, during the period when wage rates rose some 15 per cent, the cost of living rose less than 3 per cent. In the first half of 1937, the aggregate flow of money income, from government and private sources combined, was more than 10 per cent higher than in the preceding year.

THE LESSON OF THE OPA

We now turn to an analysis of the wage-price trends of the first postwar year.

The government program for controlling prices during the period of reconversion and readjustment was wrecked at the very outset by the failure to understand the interconnections between productivity, wages, and prices. Although wage rates had risen very much faster than prices during the war period, the Administration deemed it desirable to back labor's demand for a further increase, more or less across the board, of from 15 to 20 per cent. At the same time it was believed that price ceilings could, with minor exceptions, be enforced. There was no available evidence to indicate that productivity would be high enough to make such a program feasible; indeed there was much to suggest that a relatively low level of efficiency would prevail during the period of readjustment.

In abandoning wage stabilization in favor of sharp increases, the Administration turned its back upon one of the hardest learned lessons of the war period. Not until wage controls were instituted in 1942 did it become possible to hold the line with respect to prices. The experience was the same in other countries. After the war, in contrast to Great Britain which retained wage control, we scrapped it to all intents and purposes in favor of sharp wage increases.

The ability of the OPA to hold the price line was absolutely dependent upon the maintenance of wage rates. The administrative problem, extraordinarily difficult at best, became impossible once sharp wage advances more or less throughout the economy were under way. The wage increases affected the price situation in two ways.

On the one hand higher wage rates exerted a powerful push from the cost side to raise prices in order to permit profits. On the other hand, by distributing more purchasing power for the same output of goods, the pull toward higher prices from the demand side was accentuated. The wage advances added enormously to the over-all excess of purchasing power, which the Administration itself maintained was the primary source of the inflationary threat.

In any case OPA was then faced with two possible alternatives: The first was to make price adjustments in the light of changing conditions for every individual commodity, to the end that each item might be produced at a moderate profit. This alternative was, however, impossible administratively, for something like a million individual items would be involved.

The other alternative for OPA was to regard the existing price line as still, in general, satisfactory. For it was seen that if the line were once seriously punctured things would become very difficult. This involved making adjustments only in cases where genuine hardship could be demonstrated. It will be recalled that it was at first decided that no relief should be given until we had had a six months' demonstration of what business could do. This decision was based upon the fear that if an upward spiral once started the situation could not be kept in hand.

When this second alternative was adopted, business organizations naturally and inevitably sought to minimize their difficulties by concentrating production in those items where the chance for profit was best or the chance for loss was least. The result was a cessation of production in whole or in part of many commodities which thus soon became acutely short. Some of these were consumer commodities, but others were capital goods, often key items, the disappearance of which adversely affected production possibilities in a wide range of industries. While such shortages were directly the result of government policy, they appeared in the minds of many to reinforce the argument that a continuance of price control was indispensable.

It was these acute shortages resulting from price-control policy, together with the nation-wide educational campaign designed to convince the public that all prices would go through the roof if the price-control machinery were abolished, which gave the black-market operators their great chance. They operated not merely where supplies were truly short but also where they were in reasonable plenty but could not be profitably handled through ordinary processing and distributive channels. Beef afforded a striking illustration.

As I stated in September, 1945, and again in June, 1946: "The administrators of the OPA are up against an impossible administrating task. They cannot do the job item by item; and the other alternative creates shortages and stimulates black-market operations. They cannot in any case hold the line; they can only retard the rate of advance. Essential decisions cannot be made with sufficient promptness, and it has become quite impossible to enforce existing ceilings."

THE RESPONSIBILITY OF BUSINESS

Now that price control has at last been eliminated, the industries of this country have a grave responsibility. In numerous cases where government controls have eliminated or unduly restricted profit margins, prices will have to be increased somewhat. But it is of the utmost importance for the future of American industry and the free-enterprise system that businessmen, knowing that purchasing power is abundant, should not follow a shortsighted policy of raising prices in order to take advantage of a seller's market. Such a policy could only serve to shorten the period of good business and lay the foundations for subsequent collapse. This is the plain lesson of the 1919–1920 period.

Profits should be made out of production, not out of advancing prices. Profits derived from mark-ups are uneconomical and fictitious in character. Moreover, they quickly evaporate the moment the business tide turns.

Industrial price policy in the months ahead should obviously be to sell at the lowest rates possible. It is of course idle to talk of absolute reductions of prices when wage rates are sharply rising. It is, however, still the part of wisdom to insist that price rises should be held within the narrowest possible limits. Only thus can continued freedom from government control be assured and only thus can enduring prosperity be maintained.

War and Postwar
INDUSTRY *in* NEW ENGLAND

By REAR ADMIRAL M. L. DEYO, U. S. N.

COMMANDANT, FIRST NAVAL DISTRICT, BOSTON, MASS.

WHEN the Japanese war lords seized Manchuria in 1931, it was reasonably evident that they had embarked upon a program which would one day take them into the Philippines, and hence bring them face to face with the United States.

Through a network of spies and by deliberately arrogant and provocative behavior, they attempted to satisfy themselves that the American people had no stomach for war. Also, they knew their Pacific and its vast distances. They simply did not believe that we would ever attempt to fight a war to regain the Philippines. They were too far away.

From 1931 to 1934 I was at the Naval War College in Newport, first as a student and then on the staff. Each year the class, for its final exercise, played the game of a Pacific war. This was an intensely interesting problem. Our students included naval officers of varied background—aviators, submariners, battleship, destroyer, and cruiser men, as well as staff corps officers and other specialists. There were also Army and Marine officers included in each class.

In digging into this problem of a Pacific war, the fact most in evidence was that the principal obstacle would be not Japs but geography. In a naval war, and in fact in any important phases of modern warfare, there is no such thing as "living off the country." Every gun shell, every pair of shoes, every gallon of oil, and every loaf of bread has to be carried in ships.

Theoretically our fleet was as 5 to 3, relative to the Japanese fleet, but that simply meant that if the two fleets could be lined up for a conventional battle in some part of the ocean, our fleet in combatant types alone would have a 5 to 3 advantage over the Japanese. However, superiority is only superiority at the point of contact, and we knew that if we had to fight the Japanese it would be in the western Pacific and that, to reach the Philippines from our west coast, we would have to travel six to eight thousand miles, or more than twice as far as from Boston to Europe.

To confront the enemy in waters under his control, we would have to seize islands along the way and convert them into supply, repair, and rehabilitation bases. That was axiomatic. But even with a goodly number of bases upon which to build reserves of supply, our lines of communication would be so long, a decisive action would be so far in the future, that the undertaking would be far beyond anything one could visualize.

In the early thirties, this problem of a Pacific war seemed almost unsolvable. We had no fleet auxiliaries worth mentioning and almost no fast tankers, repair or supply ships that could keep up with the fleet; also, we had no bases west of Hawaii, as the Limitation of Armaments Treaty had prohibited the development of any defenses there, and the country was in no mood to build them anyway.

In one respect, this very lack of bases was beneficial to the Navy inasmuch as it focused our attention on the necessity for replenishing our ships at sea from other ships, and we developed a technique for the transfer of fuel and other supplies, the like of which has never been seen and which enabled our fast task forces, when war came, to keep the sea for unheard of lengths of time.

AN APPALLING PROBLEM IN LOGISTICS

The officers of our military services who attempted to plan a Pacific war were confronted with an appalling logistics problem, and I think that few of them were sufficiently optimistic to believe that we could ever bring overwhelming force against Japan in her own waters. At that time the military services had very little contact with the industry of the United States, and we did not comprehend its astonishing capabilities. We had worked together so little that we did not understand the men of industry nor they us. Few people realized at that time that wars of the future would be wars of whole peoples and that, if the component parts in a belligerent nation were not synchronizing, the machine would not operate to its maximum efficiency. Fortunately, the Japanese did not comprehend this themselves. They believed that they could win a short war by building up large enough stock piles of raw materials, counting upon American indifference and unwillingness to engage in a finish fight.

It is difficult even now to comprehend how the sleeping giant was galvanized into action by the blow at Pearl Harbor, converted its peacetime activities to those of war, distributed the effort throughout the nation, and delivered the finished products to distribution points from which they could be transported in ships to the forward areas in all the waters of the earth and to our Allies in the far corners of the world.

We must not forget that ascendancy over the submarine menace in the Atlantic and victory in that vital battle off Midway in June, 1942, gave us time to build up our strength, while the break-through in the iron ring of Japanese bases in August, 1942, and the heroic struggle of a few in the Solomons and in Borneo gave us a foothold from which to launch the overwhelming success of 1944 and 1945. The offensive sweep across the Pacific in 1944, including the seizure of the Gilberts, Marianas, Carolines, and the Marshall Islands, was breath-taking in its speed and boldness, but by that time the logistics problem had been solved by American industry, and when one ship went down there was always another to take her place. We knew then that we were on our way to victory.

PATTERN OF VICTORY

The weapons that were finally forged by the Navy, as a result of material aid from industry, consisted first of a spearhead which was our fast carrier task forces. Composed of three or more groups of modern aircraft carriers, fast battleships, cruisers and large destroyers, this force, constantly on the move, was capable of launching strikes of 1000 planes against selected enemy positions, and keeping up these attacks day after day for months, interrupted only long enough to take fuel and ammunition at sea from specially organized squadrons of auxiliary

An address presented at the Fall Meeting, Boston, Mass., Sept. 30–Oct. 3, 1946, of The American Society of Mechanical Engineers.

vessels. The like of this force was never dreamed of before the war, and at that time was, in fact, not technically possible.

To gain permanent control of vital strategic land areas, troops must be moved in to take over physical possession. To accomplish this end, the amphibious forces were formed. Although their fundamental characteristics had been developed by the Navy and the Marines before the war, the actual organization changed and grew unbelievably as we went along from campaign to campaign in the Atlantic, the Mediterranean, and the Pacific. The amphibious forces consisted of everything from escort carriers, battleships, cruisers, destroyers, and gunboats to transports, landing ships, and landing craft of all sizes, shapes, and descriptions. Their mission was (1) to prepare the objective for the landing, by careful charting of intelligence information and conducting the carefully planned bombardments by air and surface craft; (2) to transport the troops and their equipment to the chosen beaches in a great armada, correlating its movements and guarding it en route from submarine and air attack; (3) to land the troops in comparative safety against enemy opposition under naval gunfire and naval air support; (4) to maintain the beachhead during and after landing; (5) to provide close support to the troops while the beachhead was being developed, and until their own artillery and mechanized equipment were landed and deployed; and (6) to continue to support and supply the troops during their further advance out of the beachhead.

I would like to read three statements made by Japanese high officials since the war. The first is from Captain Ohmae, the operational planning staff officer of the Japanese naval general staff:

"The sum and substance of the loss of the war was that Japan simply did not have the war potential to stand up against the power of the United States as brought to bear by the United States Navy Carrier task forces and the amphibious forces which followed them. The speed with which you trained powerful amphibious forces was a complete surprise to us. Even though all our forces resisted to the utmost, your amphibious operations never failed once."

Mr. Rozo Asano, president, Nippon Steel Tube Company: "Steel is the basic material in war as well as in peace. Japan gets its major supply of iron ore from China and the Straits Settlements. Good coking coal is also not available here but must be shipped in from China. With the wartime requirements of more than five million tons per year, the steel industry became directly dependent on the availability of merchant shipping, thus, the state of health of steel production could be said to be directly dependent upon the operations of United States submarines. The net result was a gradual strangulation of our steel production with a consequent deterioration in the whole war effort, not only munitions but railroads, shipbuilding, and in every other field."

Mr. Shun Nomura, formerly the head of Mitsui Oil Industry: "Japan's chief supplies of oil came from America prior to the war. Therefore, since the war started, our wartime requirements which were above five million tons per year had to be supplied mostly from the Dutch East Indies. One of the decisive factors in our defeat was the activity of American submarines which cut off the supplies from that source entirely. As a consequence, at critical times, our planes could not take the air because of lack of gasoline."

The capitulation of Japan in August, 1945, found most of our ships and men ready to proceed to the assault upon Kyushu, the Japanese westernmost main island, which was scheduled to take place on November 1. This invasion would have employed over 3000 vessels, exclusive of personnel landing craft.

RAPID DEVELOPMENT OF BASES

Now a word on the development of the bases which were carved by American ingenuity from steaming jungles and coral atolls. Altogether more than 400 bases were established in the Atlantic and Pacific during the war. On the Pacific islands, the first bases were makeshift and temporary, mostly for the servicing of small aircraft. Later, staging bases were set up for anchoring, refueling, and refitting armadas of transports and cargo ships, as well as men of war. As we progressed westward we found that, with improved technique, considerable battle damage and machinery derangement could be rectified in the forward areas without returning to Hawaii or the homeland. Finally, the entire fleet could be maintained in the Marianas, Philippines, and Okinawa areas. Facilities were set up ashore with piers, roads, and shops resembling those in our home yards. Guam, for example, was seized in July, 1944. Within two months she began to operate as a base. In eleven months the stocks currently on hand at Guam could have filled a train 120 miles long. At Guam alone, 1,000,000 gallons of aviation gasoline were used per day. Her naval supply depot alone contained 93 miles of road. A harbor was built there to give safe anchorage to over 400 ships of all types. There were dry docks to accommodate the largest ships. These were floating docks, towed across the Pacific in sections, and were among the most ingenious accomplishments of the war.

In the month of June, 1945, over 25,000,000 barrels of fuel were shipped overseas in the Pacific. At Okinawa, after the final bloody campaign was won, merely to service the planes based on that one island, there were continuously required 80 large tankers, of which 30 were steaming west from the United States, one day apart; 30 steaming east, empty; 10 in the loading areas, and 10 at the beachhead.

It was on the hard-won islands of the Marianas, Iwo Jima, and Okinawa that great airfields were built from which the B-29s were at last able to operate against the heart of Japan. It took over three years to conquer the geography of the Pacific, plus the Japanese, to make this possible.

What I have said is merely to give some idea of what it means in men, ships, and equipment to support the fighting of a great overseas war. In other words, what it means to take the fighting to the enemy in preference to having him bring it to us. It is interesting to note in passing that the greatest naval effort of the war was at Okinawa although the Japanese Navy by that time had almost ceased to exist except for her air arm and submarines. Note that I have not even mentioned the tremendous activities against the German submarines in the Atlantic or in the great invasions in Africa, the Mediterranean, and France.

NEW ENGLAND'S INDUSTRIAL CONTRIBUTIONS[1]

New England's contribution to the phenomenal results obtained in converting the country to war was an outstanding and most varied one. Due to well-diversified manufacturing in New England, the region received a high percentage of total contracts—in 1942, over 12 per cent of the national total. As the heavy industries in the Great Lakes Region tooled up, New England's percentage dropped slightly, but when the need was greatest, the flexible, craftsmanlike industry of New England was able to convert and produce first. In 1945 and early 1946, when the emphasis was upon quality more than quantity, New England rose again from its wartime average of 9 per cent of the total back toward the 12 per cent of the early months of the war.

Machine Tools. Of great significance in the early days was New England's machine-tool industry. The Connecticut Valley has long been known as the machine-tool center of the nation, and it proved its worth in those early days of the war when

[1] The statistics quoted hereinafter were obtained from various reliable sources, chiefly the statistical department of the New England Council in Boston, Mass.

the whole free world was relying so heavily for its very existence on the battle of American production.

Shipbuilding. New England has always been famous for her maritime tradition and shipbuilding is one of the best elements of this. New England shipyards produced for the Navy 10,918 vessels, exclusive of all small landing craft and other small boats. These larger vessels aggregated 9,412,174 tons. In the field of small landing craft and boats which played such an indispensable role in the great amphibious invasions, New England produced 102,598. New England's yards gave the Navy 1381 combatant ships with a tonnage of over 4,500,000. One company (Bath) alone produced over 18 per cent of all the nation's destroyers built during the wartime building program. Another New England shipyard (Bethlehem-Fore River) turned out over 20 per cent of all the large *Essex*-type carriers (5 of 24) plus over 61 per cent (11 of 18) of all the heavy cruisers built in the wartime program. Over 74 per cent (180 of 242) of all the submarines constructed since 1939 were built in this area. One Connecticut company produced over 38 per cent of all the nation's submarines built during this period (94 of 242, Electric Boat).

All told, since June 1, 1940, over one third of all combatant ships constructed came from the yards of New England. Merchant ships also were built in great quantity. The War Shipping Administration received over 300 ships from the Portland (Maine) area alone. According to the W.P.B., New England's contribution since June 1, 1940, in ships alone amounted to a dollar value of $3,200,000,000. Never to be forgotten are the small concerns along the New England Coast, who with their traditional craftsmanship built so many of the fine wooden vessels used for mine sweeping and other purposes where wooden construction was essential.

Aircraft. The part played by New England in the wartime aircraft industry is somewhat deceiving for although there was only one large company (Chance-Vought) turning out finished planes, the region has made a huge contribution in parts and instruments as well as in basic research. Altogether, the contribution in planes and plane parts to the war machine was worth over $4,500,000,000, of which over $2,000,000,000 was for the Navy. In this field, where models were changing often during the war, New England's machine-tool builders counted heavily in tooling up the aircraft industry and keeping it tooled up as designs changed.

Ordnance. Ordnance contracts awarded by the services in New England amounted in dollar value to over $3,900,000,000 and, since June 1, 1940, this area contributed over 11 per cent of the national total of guns and ammunition. The Naval Torpedo Station in Newport, R. I., has long been the headquarters for the Navy's research and development in this important field.

Electronics. New England proved outstanding in producing communication and other electronic equipment. Contracts by the services to New England producers of electronic equipment amounted to just about $1,000,000,000. Those of us who went to sea will not forget the part that the first efficient radars ("S.G." Raytheon Company) played in the tense days in the Atlantic against the German submarines and in the Pacific against the aggressive aircraft and ships of the Japanese fleet, trained in night fighting and having night binoculars far superior to ours. Many an admiral and captain gave fervent thanks for our new radars.

Submarine Detection. The battle of the Atlantic could not have been won without the splendid apparatus which industry furnished the Navy for the detection of submarines. In this, New England played a prominent role. One Massachusetts concern (Submarine Signal Company), the nation's largest in this field, jumped from $4,000,000 volume in 1940, to $60,000,000 volume in 1944.

Research. Of inestimable value was the research and the development of new techniques achieved at New England's fine technical schools, which co-operated unfailingly with us.

Machinery. New England's contribution in machinery to the war effort was great, and contracts let for metal products in this area came to over $725,000,000.

Textiles. We needed not only ships, planes, guns, etc., but the proper clothes for the crews who man those ships and planes. Contracts let by the services to New England textile and leather-goods companies amounted almost to $3,000,000,000. This reached the astonishing amount of nearly 30 per cent of the national total.

Agriculture. The region's agricultural production for the war years valued at over $1,200,000,000 should not be overlooked. To cite but one example in this field, the 1943 potato crop in Maine was 70 per cent above the State's average for the previous ten years.

Sea Food. During the war years when, especially to our Allies, food assumed the role of a weapon, New England's contribution of over 4,000,000,000 pounds of fish was particularly significant.

Wood Products. The Navy's needs for wood and wood products were many and varied. New England contributed heavily with a production of over 10,000,000 cords of pulpwood and over 5,200,000,000 board feet of lumber during the war years in spite of the loss of almost one half of the labor previously available for this purpose.

Transportation and Communication. Not to be overlooked is the contribution of the transportation and communication systems in getting material as well as personnel to their destinations. Long-distance calls carried by the New England Telephone system rose to 40 per cent over the prewar 1940 average.

Power. New England's power production rose from an average in the five years before the war of about 7,500,000,000 kwhr to a wartime annual average of 10,500,000,000 kwhr. This was possible because of the great foresight and boldness of the power company officials.

With only 2.2 per cent of the nation's land area and about 6.4 per cent of the nation's population, New England turned out more than 9 per cent of the total war supplies. New England's engineers, constituting the technical ability of the region, who did so much of the planning and integrating necessary to spark this huge effort and keep it rolling smoothly, deserve the special thanks of the nation.

A GLANCE INTO THE FUTURE

The future is perhaps anybody's guess. We hear of poison and bacteria, of push-button wars where guided missiles with atomic war heads are sent halfway round the world to lay waste the production centers of nations, without using airplanes, ships, or soldiers. If that day comes (and it is still a long way off), man may wipe himself out and have to wait for another Adam and Eve. So far the history of man's contrivance of instruments with which to destroy his neighbor has been that for every offense an effective defense is eventually devised. Six years of the most destructive war the world has known has not materially decreased the population of this earth. Nevertheless science is uncovering the secrets of nature and life with an accelerating speed and man is now forging tools which can easily wipe him out of existence.

We are too close to this last war to have analyzed its lessons but some things are already apparent:

1 This country after it got into gear, and without an undue amount of regimentation, produced an unheard of amount of war material. In this the people showed a willingness to pull together unprecedented in our history. This is indeed a sig-

(*Continued on page 116*)

Value of WET COMPRESSION *in* GAS-TURBINE CYCLES

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THE development of high-efficiency gas-turbine cycles has frequently been regarded as requiring (1) extremely high cycle temperatures; (2) high mechanical efficiency of turbines and compressors; (3) large amounts of heat-exchange surface for regenerators and intercoolers. Although all of these elements are basically desirable they do not represent by any means the entire range of possibilities. In order to visualize other possibilities of developing high-efficiency cycles, we should consider for a moment the peculiarities of the gas turbine as compared with other prime movers.

HIGH BACK-WORK RATIO OF GAS TURBINE

A major characteristic of the gas turbine is that it has a high back-work ratio. The term "back-work ratio" will be used so frequently in this discussion that it should be carefully defined. As here used, it is the ratio of the total mechanical work which is absorbed by compressors and other equipment necessary to the operation of the cycle, divided by the total work generated by all turbines or other prime movers in the cycle. In the case of the conventional steam cycle, the back-work ratio is thermodynamically the work used by the boiler feed pump divided by the output of the turbines. Practically, however, the power consumed by all the auxiliaries, such as forced- and induced-draft fans, lubricating-oil pumps, etc., should be included in the back work.

In the case of the steam cycle this back-work ratio seldom amounts to more than 2 to 5 per cent. In the case of the gas-turbine cycle, on the other hand, the high work of compression of the large volumes of air used necessitates back-work ratios of the order of 50 to 80 per cent. For illustrative purposes, we may take a typical gas-turbine cycle as having a back-work ratio of $^2/_3$ ($66^2/_3$ per cent). Such high back-work ratios have two important effects on the properties of the cycle. Since in this case 2 out of every 3 hp developed are used to drive compressors or otherwise are absorbed in the cycle to give a net output of 1 hp, any inefficiency in either the power-generating or power-absorption equipment rapidly cuts down the net output. Thus a 5 per cent reduction in turbine efficiency in the illustrative example amounts to a 15 per cent reduction in net output, while a 5 per cent reduction in compressor efficiency adds another 10 per cent reduction in net output.

A second effect of high back-work ratio is on the size and cost of equipment. We may roughly assume that turbines and compressors will cost approximately a certain amount per horsepower. This being the case, the cost of equipment for a back-work ratio of $^2/_3$ will be 5 times the cost of a simple turbine having a given output, and a similar ratio holds approximately for the weight and volume of equipment.

Although this effect of back-work ratio merits a much more extensive discussion, the foregoing is perhaps sufficient for our present purpose to indicate that important improvements can be made by any means which will reduce the back-work ratio of the cycle. One obvious way which has been used is to intercool the compressor in one or more stages. On second thought, however, it seems a bit ridiculous to remove heat from the fluid which is then immediately to be subjected to additional heating.

"WET COMPRESSION" TO REDUCE BACK-WORK RATIO

An effect similar to but better than intercooling can be obtained, without actually removing heat from the cycle, by compressing a mixture of finely divided liquid water suspended in the air. The heat of compression of the air is absorbed as latent heat in the water which is evaporated. At low compression ratios, such as are now used in gas-turbine cycles, the amount of water required is of the same order of magnitude

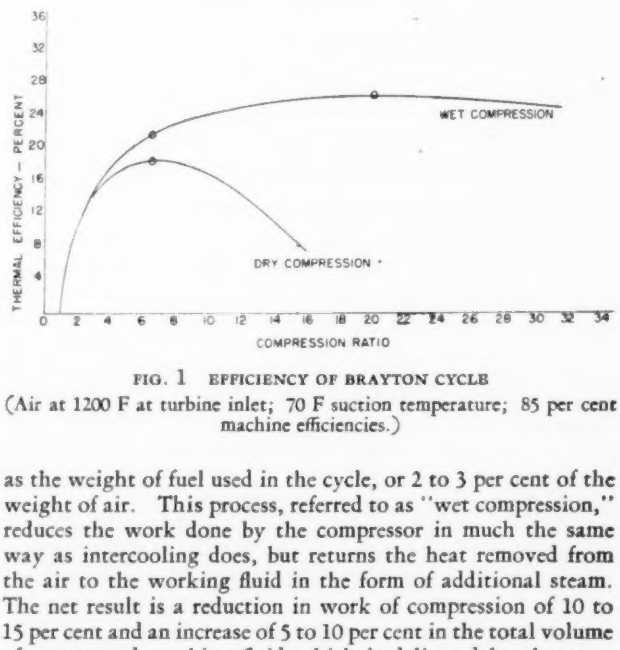

FIG. 1 EFFICIENCY OF BRAYTON CYCLE
(Air at 1200 F at turbine inlet; 70 F suction temperature; 85 per cent machine efficiencies.)

as the weight of fuel used in the cycle, or 2 to 3 per cent of the weight of air. This process, referred to as "wet compression," reduces the work done by the compressor in much the same way as intercooling does, but returns the heat removed from the air to the working fluid in the form of additional steam. The net result is a reduction in work of compression of 10 to 15 per cent and an increase of 5 to 10 per cent in the total volume of compressed working fluid which is delivered by the compressor. This brings about a reduction from $^2/_3$ to $^1/_2$ or less in the back-work ratio and an increase in the net power output from the cycle, for a given size of compressor, of as much as 20 to 30 per cent.

Fig. 1 shows the efficiency and net energy per pound of working fluid for the simple Brayton cycle, with ordinary dry compression and with wet compression. The efficiency is raised from 18.8 to 22 per cent.

However, a further beneficial effect is obtained, also illustrated in Fig. 1. It is well known that a simple gas-turbine cycle has its maximum efficiency at a relatively low compression ratio which in most modern gas turbines is from 3 to 6, depending on compressor efficiency and maximum cycle temperatures. In Fig. 1 this maximum is at about 6.5 compression ratio. Wet compression not only increases the efficiency

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and capacity of the cycle at a given compression ratio but also raises the compression ratio at which the maximum efficiency occurs and therefore again raises the thermodynamic efficiency.

In Fig. 1 this maximum is at a compression ratio of about 20, and the efficiency is further increased from 22 to about 26.5 per cent. It also increases substantially the power output per pound of air handled, and therefore increases the power output from a given-size compressor.

Fig. 2 shows the energy per pound of working fluid for the

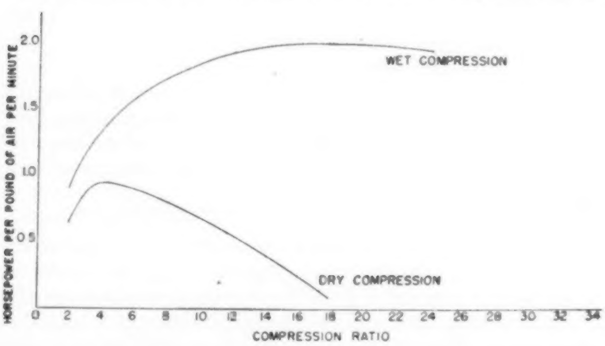

FIG. 2 HORSEPOWER PER POUND OF AIR PER MINUTE TO COMPRESSOR

(Same conditions as Fig. 1.)

two cycles. The result of these factors is to make possible a simple gas-turbine cycle without regenerators, and without intercoolers, which may have some 20 per cent better fuel economy, and at least 50 per cent higher output per pound of air handled than conventional machines. The practical result is a marked decrease both in operating cost and in first cost.

OPERATING TESTS WITH WET COMPRESSION

Although gas turbines especially designed for wet compression have not yet been built or tested, a few results have been obtained by operating with wet compression a gas turbine designed for conventional operation. These tests have confirmed (1) the reduction in compressor power required; (2) the increase in thermal efficiency; (3) the very marked increase in capacity of a given-size equipment; (4) the basic fact that wet compression does occur at least in one type of commercial compressor in much the manner that was expected theoretically. In other words, the air and water appear to maintain approximately the equilibrium assumed during compression.

The problem of water supply for wet compression is naturally of considerable importance. Since the water is almost entirely evaporated in the compressor, any solids contained in the water will tend to precipitate in the compressor. It is therefore desirable to use extremely pure water, if available. The vapor-compression distilling unit, developed by the author and co-workers in the laboratories with which he is associated, gives promise of being integrated with the gas-turbine cycle to give a highly efficient source of pure water for wet compression.

The improvements in gas-turbine operation to be expected from wet compression are so great that a special study of wet compression in other types of compressors is indicated. The results mentioned are obtained with a rotary positive-replacement type of compressor, a type which is possibly exceptionally favorable for this service. It is highly desirable that similar studies be made with axial-flow and centrifugal compressors, since the high blade speeds in these types may introduce losses, erosion, or other factors which will complicate the problem.

One incidental effect of wet compression which may be of considerable importance is the fact that the compressor operates at very nearly constant temperature from the inlet to the exhaust flange. It is therefore not subject to the temperature stresses and deformations that tend to occur in ordinary compressors where temperature rises of 200 to 300 deg F are usually obtained, and which limit compression ratios obtainable without intercooling. This would make possible design of compressors with closer clearances, and therefore with higher efficiency than normal.

The wet-compression gas-turbine cycle is covered by patent applications on which the United States Government has shop rights. It is a wartime development sponsored by the U. S. Navy which promises to have additional important industrial applications.

War and Postwar Industry in New England

(*Continued from page 114*)

nificant lesson at a time when the tendencies are to pull apart.

2 The ability and willingness of our people to work long and hard showed that we are still youthful and have healthy blood. The thing we have to fear most today is the foolish notion that man can prosper without hard work. We know that the backward countries of this world are the ones where you see the men sitting around and talking politics during working hours.

3 On the whole, the indifference of our people toward their Government through many years has been harmful. The quality of men in public office has generally not been nearly up to those in industry, nor has their performance been as satisfactory.

One of the greatest lessons for the future is the responsibility of every citizen for good government. A nation has as good a government as it deserves. No better.

4 Men continue to be selfish and greedy; but on the whole, men of education are more reasonable and less likely to be swayed by foolish doctrines than those who are not educated. The importance of this fact cannot be overemphasized in this postwar period when there is being conducted right now an ideological war all over the world. Industry probably contains a higher percentage of educated, capable, and sensible men than the other activities of this nation. Men of industry therefore must assume a high responsibility in solving these problems, the chief of which is man and his relations toward man. It is well to remember that it was perhaps the selfish indifference and blindness of the industrial leaders of the past that led to the labor predicament of today.

5 To pull together in time of peace is not easy or popular. But if we would do so, and present a united front to the world, I doubt that we would have to fear another war.

It seems to me that organizations like this Society can do more than merely improve their own professional interests. They can, because of the character of their membership, take action toward the realization of better government and better citizenship.

Meanwhile, I hope very earnestly that the stimulating and helpful association of the Navy with New England industry during the past war will continue and grow for our mutual benefit and for that of our country, because, when our Army and Navy are needed again, they will not have a year or two to build up their strength. We need industry's help now and always to keep us strong and ready.

The Use of ELECTRIC GAGING EQUIPMENT *in* MACHINE DESIGN

By P. E. NOKES and E. G. CARR

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WITHIN a reasonable degree of precision, the design engineer has long been aware of the properties of the various materials he is called upon to use. However, he has in the past largely failed to achieve a comparable knowledge of the loads, accelerations, velocities, or hydraulic pressures in his mechanical systems during actual operation. Largely this failure can be attributed to lack of a basic system capable of following mechanical phenomena at customary working speeds. Much ingenuity has in the past been expended in an effort to design mechanical recording systems for this purpose. The usual end result, unfortunately, has been a mechanism which was complex, expensive, subject to error due to inertia, friction, and the like, and, worst of all, a single-purpose instrument.

During the past few years, several electrical methods of measurement have come into prominence in the strain-analysis field. These are all characterized (*a*) by a fairly simple and inexpensive strain- or movement-sensitive device, (*b*) by a specialized amplifier of considerable complexity, and (*c*) by a recording device. The real virtue of these systems lies in the fact that the complex and expensive amplification and recording system is standard from job to job. Only the least expensive and complicated part need be modified to suit the conditions peculiar to the individual project.

BASIC APPARATUS

A variety of considerations governs the choice of apparatus for electric gaging, and these considerations have been amply covered in detail by other writers. In general, what is required is some form of Wheatstone bridge, the permanent and adjustable half of which is contained within the apparatus itself. The remaining half of the bridge, consisting of either two active strain gages or one active gage and a dummy is, of course, located on (or adjacent to) the part to be tested. It would be possible to supply this bridge from a direct-current source, in so far as the gage system is concerned, and this source would have the property of covering any desired frequency range. However, because of amplifier considerations, it is customary to supply the bridge from a source (usually an electronic oscillator) having a frequency between 1000 to 5000 cycles per sec. A means is provided, at the output end of the amplifier, for removing this frequency from the record. The bridge and its components must be of proper design and construction, since the maximum variations to be measured are only of the order of magnitude of 0.5 to 0.75 per cent.

Since the output is very small, the bridge is followed by an amplifier which increases the bridge output sufficiently for recording or other purposes. Little need be said concerning this component of the system, except that, again, it should be of the best quality and properly designed for the purpose. The usual general-purpose speech amplifier one finds about the laboratory will not be adequate.

The amplifier system is followed by some form of indicating or recording device. For general work, static or dynamic, a multi-element bifilar oscillograph will be found most useful for design engineering.

PARTICULAR APPARATUS

In order to illustrate the type of apparatus which it may be necessary to devise on the spot to cover a particular job, several illustrations of special "gadgets" have been prepared. These are intended to show the type and complexity of the devices and to indicate the ingenuity required in their design, rather than to illustrate the solution to special problems. These illustrations do not represent the last word in precision. They do, however, represent practical solutions to problems which continually face the average design engineer.

In Fig. 1, *A* shows a device used to determine loading between two flat surfaces. It will be recognized as a simple beam, supported at both ends and loaded in the center. It was designed for loads of several thousand pounds and, as shown, carried a resistance-wire strain gage for measuring purposes. Calibration was obtained with a compression testing machine of proper capacity. It is easily realized that various exceptions can be taken to this device by the person interested in high precision. However, it enabled its user to obtain the data with quite sufficient accuracy for the problem in hand. Further, these data were obtainable in no other way.

In Fig. 1, *B* represents a different problem in loading, namely, the load produced over a small area by a rubber pad pressed against an irregular piece of wood. The device itself consists of a small cantilever beam, of about $^3/_4$ in. unsupported length. It is fastened at one end, by a screw, into a small steel box. A resistance-wire gage is attached to the cantilever. The entire box is set into the piece of wood with its upper surface flush with the wood surface.

In Fig. 1, *C* represents an interesting attempt to obtain the loads existing at certain points on the human foot due to the wearing of shoes. It consists of a rectangular steel plate about 0.05 in. thick, to which is cemented another steel plate having its end, *a*, formed into a bow. The act of applying pressure flattens and therefore stresses the bow. The bow part has a small wire strain gage cemented to it, which produces the actual measuring signal. In use, the entire device was coated with rubber and attached to the foot by means of adhesive tape.

Device *D*, Fig. 1, was produced for the specific purpose of calibrating device *C*. In use, *D* is held in the hand, *C* being in place on the foot, and, with both it and *D* connected to the recording device, button *b* is pressed slowly onto bow *a* of the foot gage and released. An entire calibration curve for device *C* can thus be obtained in one movement. Device *D* is then calibrated by loading it with known weights.

Illustrating further the use of resistance-wire strain gages, Figs. 2 and 3 show devices used successfully for the measurement of hydraulic and pneumatic pressures. Fig. 2 shows a device for measurement of pressures up to 1000 or 1500 psi and is particularly useful for those ranging from a few pounds per

Contributed by the Machine Design Group and the Applied Mechanics Division and presented at the Annual Meeting, New York, N. Y., Dec. 2–6, 1946, of The American Society of Mechanical Engineers.

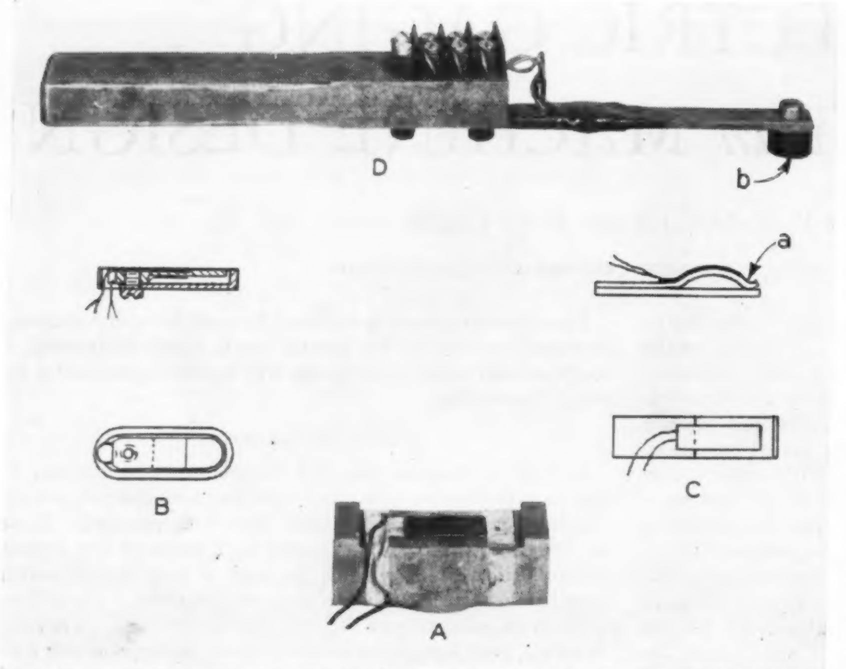

FIG. 1 VARIOUS APPLICATIONS OF WIRE STRAIN GAGES

square inch to several hundred pounds. It consists of a steel box with a shaped recess at *d* extending completely through the cover. Fitting freely in this recess is a small steel beam supported near either end by knife-edges attached to supports *e*. The wire gage is obvious in the illustration. In order to seal the small clearance between the beam and its recess, a very thin synthetic-rubber diaphragm is placed between box and cover. The device is connected at *f* and is calibrated statically against a pressure gage of known accuracy.

Fig. 3 shows a type of pressure gage adapted to higher pressures. The one illustrated was designed for pressures up to 50,000 psi. It consists of nothing but a closed-end thick-walled tube, machined from solid stock. The strain gages applied can be readily seen. An interesting feature of this gage is the fact that it was first used for measuring the pressure of a hot gas blast. Accordingly compensation for thermal expansion of the tube and for thermal-resistance changes in the wire of the gage was mandatory. The effect was achieved by measuring both circumferential and longitudinal strain in the part, but using the difference in these two strains as a measure of the internal pressure. Calibration was achieved by filling the tube with a semi-fluid grease, inserting a well-fitted piston, then applying known loads to the piston with a compression testing machine.

In Fig. 4, *A* shows an interesting device, which is applied in the manner of a hand tachometer. A cardioid cam *g* bends a light cantilever beam *b* in such fashion as to produce a final record which is linear with respect to the rotation of the driving shaft. Therefore it not only counts revolutions of the driv-

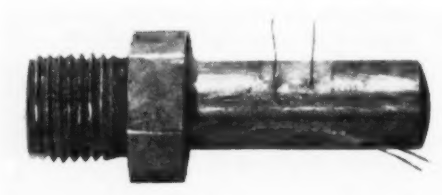

FIG. 3 DEVICE FOR MEASURING HYDRAULIC OR PNEUMATIC PRESSURES UP TO 50,000 PSI

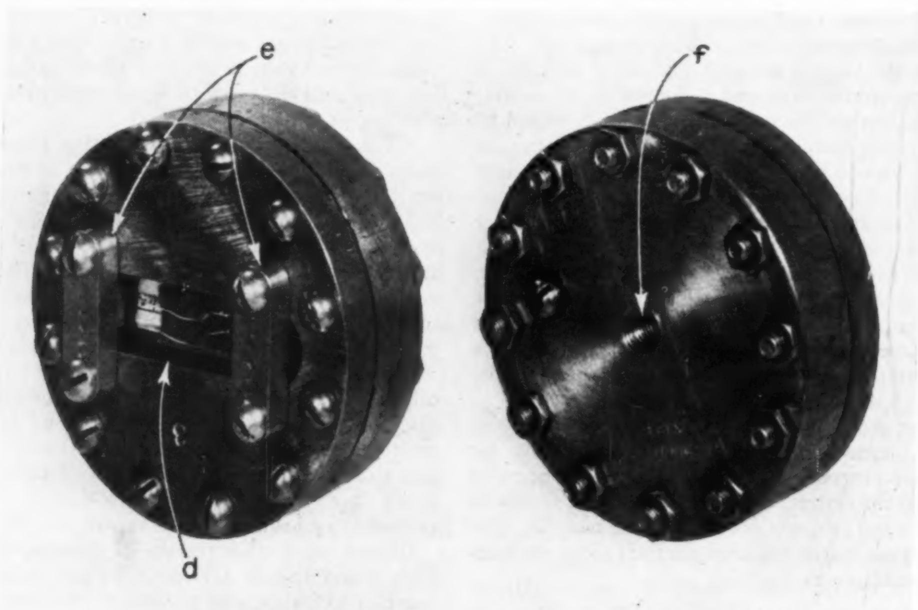

FIG. 2 DEVICES FOR MEASURING HYDRAULIC AND PNEUMATIC PRESSURES UP TO 1500 PSI

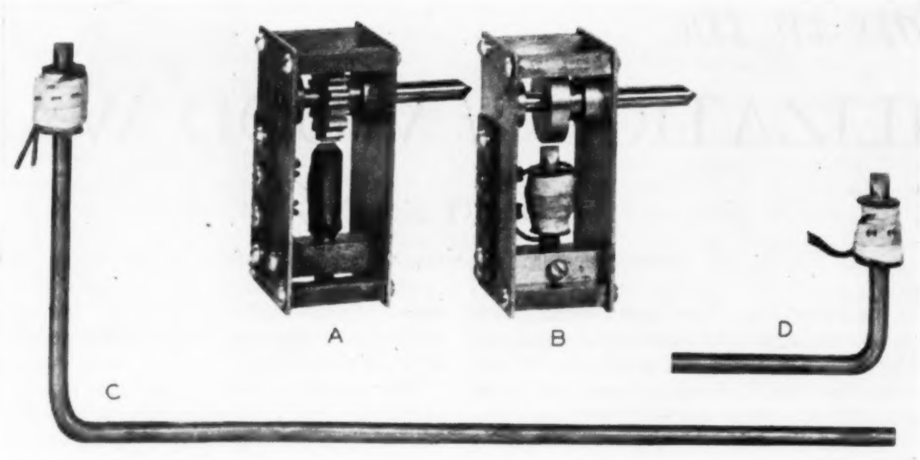

FIG. 5 INSTRUMENTS HAVING IRON-CORED INDUCTANCES UTILIZING MAGNETIC RATHER THAN ELECTRICAL CHARACTERISTICS FOR MEASURING PURPOSES

ing shaft but also the details of each revolution. From the curves obtained, rotational velocity and acceleration can be computed readily.

Item *B* in Fig. 4 is a most versatile method of recording motions of parts, particularly where such movements cover several inches. As shown, a piece of spring stock (0.015 to 0.050 in. thick) is equipped with wire strain gages. One end is clamped in any convenient fashion to a stationary part of the machine. The free end is allowed to spring against, and move with, the part under test, thus producing the desired record. It might be thought that this device would produce a signal departing somewhat from linearity. It does; but under proper conditions, the departure is not great and numerous instances have shown that, in spite of this fact, the device is extremely useful. Calibration may be obtained with anything from a scale to a micrometer, depending upon circumstances.

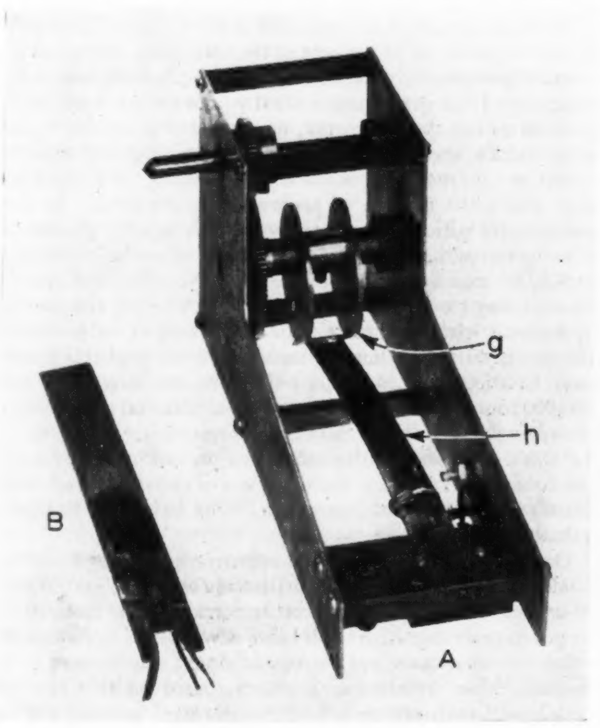

FIG. 4 AT RIGHT IS SHOWN A TACHOMETER-TYPE MEASURING DEVICE, WHILE TO THE LEFT IS AN INSTRUMENT FOR RECORDING MOTIONS OF PARTS

Fig. 5 represents a rather different approach to measurement problems using the subject apparatus. In the examples pictured, iron-cored inductances are substituted for the wire strain gages previously discussed. These are, in general, set up in such fashion that the magnetic rather than the electrical characteristics of the device are varied in response to the phenomenon under investigation.

Items *A* and *B* in Fig. 5 are what might be described as lightweight free-running tachometers. They can be attached to rotating parts without absorbing power and produce records which may be readily translated into movement, velocity, or acceleration. In type *A* the small rotor consists of a multitoothed gear. In type *B* a cam is used giving a sinusoidal output.

Items *C* and *D* represent general-purpose devices, consisting of steel rods, bent to suit the case, on each of which is wound a small coil of wire, thus forming an inductance. By placing these in a machine with the free end near to, but not touching, a rotating gear, screwhead, or other ferrous protrusion, angular velocities and accelerations may be described. Likewise, by placing them in close proximity to a shaft, lateral deflection and whip of the shaft may be recorded. With increasing familiarity, other uses will suggest themselves.

CONCLUSION

The foregoing dissertation has been an attempt to show the design engineer possible further uses for apparatus of a general and versatile nature, which he may have considered only in connection with actual stress-analysis work. The apparatus is capable of considerable precision in the hands of experienced personnel. However, this paper takes the definite stand that the apparatus may be extremely useful to the design engineer who can be assisted materially by data of not too great precision. He need not be an expert to obtain such results.

For those wishing to go into details of apparatus and method, the "SR-4 News Letter," published by the Baldwin Locomotive Works, can be highly recommended. A comprehensive treatment of the subject has also been given by Howard C. Roberts.[1] The Proceedings of the Society for Experimental Stress Analysis contains useful and instructive papers on the subject.

[1] "Electric Gaging Methods," by Howard C. Roberts, *Instruments*, vol. 17, March, 1944, p. 192; continued serially to vol. 18, October, 1945.

Problems in the UTILIZATION *of* WOOD WASTE

By ROBERT S. ARIES

DIRECTOR, NORTHEASTERN WOOD UTILIZATION COUNCIL[1]

THE forests of the United States have been a source of untold riches for centuries, yet the processes of utilization have generally been haphazard and inefficient. It is a painful fact that more than two thirds of the forest drain is lost during manufacture and use. About 1 ton of wood per thousand board feet of lumber is left at the sawmill as sawdust, slabs, and edgings, while 3 tons are left in the woods as tops, limbs, broken and cull logs, cull trees, and noncommercial species. It is indeed a field worthy of more attention by engineers, not only from the point of view of conserving an important natural resource, but also because it should offer attractive possibilities for achievement and success.

More than 20 years ago the Forest Service of the United States Department of Agriculture published a table indicating the yield and efficiency in the utilization of wood. At that time we were discarding 2 tons of the wood in the forest for every ton of seasoned, unplaned lumber. Of the log brought to the mill, only 46.4 per cent reappeared in the form of unplaned lumber. Progress in two decades has been slight. It is estimated that out of 181 cu ft in log form, furnished to the sawmill, 1000 ft of sawed timber are produced, which are equivalent to 94 cu ft, indicating a yield of 52 per cent. Slabs and edgings amount to 32 per cent, sawdust to 13 per cent, and firewood and refuse make up 3 per cent of the weight. This lumber is then further subject to wastes in final manufacture, building trades wasting 15 per cent and furniture 75 per cent.

ARE FORESTS BEING DEPLETED?

Much information on forest resources and their utilization has been made available. Unfortunately, some of this contains statements which result in confusion or misunderstanding on the actual forest situation. Some even tends to promote the idea that there is nothing to worry about. Since one third of the area of the United States is forest land, some may think that there will always be an abundance of timber. However, it does not follow that forest land necessarily means productive timberland. According to forest-service figures, of some 630,000,000 acres of forest land in the United States, approximately 168,000,000 acres are of noncommercial types, that is, alpine, semidesert, chaparral, or other forest-land types not suited or not available for growing timber of commercial quality or quantity, although much of it is valuable for watershed protection, grazing, wild life, or other purposes. Of the 462,000,000 acres of commercial forest land, some 77,000,000 acres is virtually nonproduction as a result of destructive cutting and fire. Of the remaining area all but about 100,000,000 acres has been cut over, and a large part of this cutover land is now producing at only a fraction of its potential capacity. This nonsalable wood is the biggest problem in the Northeast and other similar areas. Uses should be found for the "thinnings" of such areas, so that in the future we may get timber of saw-log quality in increasing amounts.

The amount of usable wood that can be supplied annually does not depend upon the acreage and character of the land alone. It depends as much upon the character of the growing stock, i.e., the number of remaining trees large enough and of the proper kinds to produce good saw logs, piling, pulpwood, etc., in a short time. Therefore our growing stock, or forest "capital," must be maintained if it is to yield regular "interest" in the form of usable products.

Besides, the quality of the second-growth timber is much inferior to that of the original stands in so far as lumber is concerned. That is where common sense and a scientific attitude are of importance. The creation of organizations such as the Northeastern Wood Utilization Council, for example, is one answer to the problem. The forests of the Northeast, like the ones of several other regions, were pronounced as "doomed" by pessimists even before the turn of the century. Yet sawmills are still humming and by means of utilizing low-grade materials and wastes, the area can continue to be one of a prime manufacture of forest products.

FOREST CONDITIONS IN NEW ENGLAND

The total acreage of forested land in New England is close to 30,000,000 acres, or 70 per cent of the total area, and wood is a renewable resource, as contrasted with oil, coal, and other minerals. High-grade timber usually finds a market and brings good returns to the landowner, but an outlet is lacking for the wood which should be taken out in weeding and thinning operations. Low-grade wood is left to cumber the forest and slow down the growth of promising timber trees. In Connecticut, for which we have fairly accurate figures, the amount of unharvested, because unsalable, cordwood has been estimated at 500,000 tons a year, and in the entire New England area the amount may reach 5,000,000 tons. In lumbering and sawmill operations, where not more than 40 per cent of the volume of the tree is utilized as lumber, unsalable waste probably runs to over 1,600,000 tons, and the pulp mills are wasting at least 400,000 tons. The annual total of wood material now going to waste in New England may be conservatively estimated at 7,000,000 tons, and similar conditions prevail in other parts of the country. Yet this is the very class of material which wood chemists in the United States and abroad have been finding so valuable.

One of the main problems and opportunities facing New England in the postwar era is the utilization of these 7,000,000 tons of unused wood. If a considerable portion of the material can be put to profitable use, it will bring new revenue to farmers and other timber owners and create additional employment in the forests. New woodworking plants, based on this raw material, will multiply manyfold the increased income and employment. The improvement of timber stands which such utilization would make possible will be reflected in an increased return from lumber production in the area.

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Contributed by the Wood Industries Division and presented at the Fall Meeting, Boston, Mass., Sept. 30–Oct. 3, 1946, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

It should be clear that in most cases the lumber would still have to carry the major part of the cost. New uses of wood should not be considered as competitive materials of lumber. The latter still remains and will probably continue to be the main product of the forest, but it will not be the only product as up to now. Other wood materials should supplement and enlarge its scope as well as increase its value (or decrease its cost) on account of the utilization of parts of the tree which were formerly wasted. In the future, the lumberjack, forester, engineer, and executive should work together in a comprehensive program for the benefit of all. This is the aim of the Northeastern Wood Utilization Council and other forward-looking organizations.

The utilization of wood waste and wood is oftentimes represented as an entirely new discovery with amazing and revolutionary potentialities. It is our opinion that this attitude has sometimes created more harm than good. Those who really work with wood are used to the slow growth of trees and should get accustomed to a solid and tested foundation rather than be impressed by the mere newness of a development.

RELATIVE IMPORTANCE OF WOOD PRODUCTS

About one half of the products into which wood is converted consists of lumber. The other half finds diversified uses, a great part for fuel. Estimated figures, Table 1, in million cubic feet for 1943, announced by the Forest Service, include the tops and limbs, without the bark.

TABLE 1 PRODUCTS INTO WHICH WOOD IS CONVERTED (MILLIONS OF CU FT)

Lumber	6789	Veneer logs	441	Tight heading	9
Fuel wood	3501	Mine timbers, round	238	Shingles	67
Ties, hewn	281	Slack staves	51	Poles	39
Fence posts	248	Slack heading	24	Piling	
Pulpwood	1333	Slack hoops	1	Distillation and tanning wood	65
Miscellaneous logs and bolts	129	Tight staves	31		

This tabulation gives the range within which important contributions to waste utilization can be made. The proportion of softwood to hardwood in the total consumption is close to 2.7 to 1, while in pulpwood it is 8.6 to 1, a ratio which is likely to change with the increased trend toward hardwood utilization.

It may be estimated that there are about 100,000,000 tons per year of wood which are not utilized. The chemical methods of utilization have received greater prominence in recent years, although the mechanical are just as important. Even the chemical methods involve more engineering than chemistry. Thus the currently *en vogue* production of wallboards from wood waste involves in most cases the simple addition of a binder to the waste. The mixing, pressing, drying, and other engineering operations are by far the critical ones to be considered. In this field, as in all the others, the engineer can make a definite contribution.

The present discussion will center itself on some of the more important aspects of engineering utilization of wood waste, as chemical conversion has already been amply covered in the literature. Although not treated in the discussion, it should be borne in mind that, because the cost of wood as a raw material should be kept low and this cost largely represents labor, a great deal of attention should be given to labor-saving methods in harvesting of wood, i.e., the use of mechanical power in place of human muscle, and improved methods of handling a bulky material. The rise of power saws has expanded tremendously during the last 6 years and promises to develop further. This and other methods of cost and waste saving in the preparation of wood for manufacture represent an entirely new field which will offer rich dividends to engineers who tackle them successfully.

LAMINATION OF SMALL PIECES OF WOOD

The lamination of wood represents an excellent opportunity to use small pieces from sawmill waste as well as the successful milling of low grades which are not suitable for saw timber. In addition, a large amount of low-grade and short-length pieces can be used in the interior laminations. The ease of drying of small pieces, as compared with the seasoning difficulties and defects of large timbers, is a further advantage of lamination. A region of second-growth timber, such as the Northeast, is particularly suited for lamination developments.

When the United States entered the late war, there was a scarcity of large timbers to meet the gigantic construction schedules of the Bureau of Ships. Although there was no shortage of standing timber, it was realized that the supply of large oak timbers, vitally needed in shipbuilding, was very limited. Furthermore, the time required to obtain large oak logs from the forest, process them at the mill, and season the timber was excessively long. It was estimated that only one tree out of 200 in an oak forest was suitable for ship timbers, and only a small portion of that tree would make bending oak. Glue lamination solved this problem by making large pieces of oak out of small ones. The process reversed the age-old course of dividing big pieces of wood into smaller ones.

Laminating eliminates many of the principal joints, thus producing stiffer, stronger members. The three fundamental structural parts of a ship, viz., stem, keel, and stern post, may now be turned out by laminating a single, prefabricated unit, without joints, bolts, or other fastenings. As this technique develops, a trend among naval architects toward lighter construction in ship design will probably occur. Before the war there was very little lamination because the proper glues had not been discovered, but modern resin glues made marine plywood possible. Further improvement in them and in the manufacturing processes will be effected as the work continues, and numerous other applications for laminated wood will be found.

Laminated arches and beams, now glued instead of nailed, are being used to support heavy loads, span long distances, or to achieve maximum strength and rigidity with minimum weight. The trend results from the fact that modern laminating techniques, at a reasonable cost, make it possible to manufacture wood beams larger in size than solid timber, and in shapes both difficult and expensive to produce in steel.

Laminating overcomes many of the limitations inherent in wood, brings out its strong points, and lends itself to long, narrow, deep structural timbers. Since relatively thick boards can be easily and quickly dried, lamination makes possible large timbers thoroughly seasoned throughout, a feature almost unobtainable in solid timbers. By using what is technically known as a scarfed joint, timbers of any length can be obtained which develop high strength throughout. High-strength high-grade materials can be combined with low-strength low-grade stock, the stronger pieces being placed where stresses are heavy, the weaker where they are light.

The advent of dependable adhesives combined with other advances in wood technology, such as timber preservation and sound timber engineering practice, promises to make laminated timber and glued-work construction of ever-increasing importance in the future. Not only can laminated wood compete with steel and concrete in heavy construction, but it is also expected to find a definite place in housing and in the manufacture of furniture. Poles, posts, piling, railroad ties may all be made by laminated oak harvested in the Northeast and processed by its skillful workers. The peacetime boatbuilding

industry is also expected to be a large consumer. The further development of electrostatic heating may give it an additional impetus. The advantages of lamination are that any desired shape can be made easily and subsequently machined in a plant which requires relatively little investment. It undoubtedly represents one of the most effective attacks on the utilization of wood considered as waste until the present.

MECHANICAL UTILIZATION OF WOOD WASTES

A very wide field may be covered by products "mechanically" converted or manufactured into small wooden articles. For the average alert manufacturer, this field represents the easiest method for waste utilization. It includes products such as lath, shades, and map rollers, matches and toothpicks, signs, toys and novelties, picture frames, brushes and handles, dowels, etc. The usual product is small square-edged material; "dimension stock," and "squares." Occasionally finished and semifinished commodities are made from wood refuse at the point of waste production.

Dimension stock and squares can be made from small, crooked, knotty, and defective logs, from tops, and from large branches of trees. Slabs, edgings, and trimmings and, to a less extent factory wastes are also made into dimension stock and squares.

During the manufacture of softwood yard lumber, large quantities of material in lengths under 8 ft now go to waste outright or are so used as to yield but a fraction of their real value. The bulk of these "shorts" are 4 and 6 ft long, since odd lengths are not commonly made in softwood lumber manufacture. Short-length lumber occurs as rough square-edged stock, chiefly as a result of taper, crook, and defects in logs and as surfaced, worked, or patterned material from planing-mill operations.

Short-length stock constitutes approximately 5 per cent of the total volume of softwood yard lumber, marketed under the regular specifications. It is thought that if all the suitable material available at sawmill operations under present practice were utilized in the production of short lumber, such stock would constitute at least 10 per cent of the total volume of softwood yard lumber produced.

Hardwood lumber is marketed in the regular grades in lengths as short as 4 ft. Pieces up to 4 ft long and at some mills longer pieces are quite commonly wasted. A great deal of this short-length lumber is clear material and could be used to advantage in many of the hardwood-using industries. More complete utilization of short lengths in hardwoods is very desirable and, if carried out to the limit under present manufacturing practice, would help materially to conserve our stand of hardwood timber.

Low-grade lumber, slabs, edgings, short stock of both hardwoods and softwoods are sometimes made into box shooks and crating material. This is done at the mills, or the material is trucked or shipped to box factories for conversion. The enormous volume of box and crating stock consumed suggests that suitable waste and low-grade material can be used for those items to the limit, in so far as such operations may be profitable.

Excelsior is commonly made from 18-in. bolts of fairly large-sized stock chiefly of basswood, aspen, cottonwood, and southern yellow pine. Considerable material of the proper species suitable for excelsior stock can, no doubt, be made from waste wood. It can be made from square-edged pieces as small as $1 \times 1^1/_2 \times 6$ in.

POSSIBILITIES FOR FURNITURE

Most of the furniture manufactured in the United States is made from high-grade lumber, yet most of the wood specified for it can be supplied by the second-growth material, such as that available in the Northeast and elsewhere. The main arguments against such woods are that they are poorly sawed and badly seasoned and unable to meet kiln-dried specifications.

This is a challenge to potential manufacturers who should set up facilities that will enable that material to be sold in a condition that does not deliberately ruin its possibility for use. Dependable sawing and kiln-drying facilities should be established to supply the raw materials for modern furniture factories. Furniture and assembly shops using recently developed techniques in plywood and laminated wood require a comparatively small capital investment and should prove to be a lucrative business for progressively minded wood plants.

The tremendous plywood industry which has developed in the United States will probably experience a further rise in its production on account of the strength, nail-holding ability, uniformity of properties, the lightweight units characteristic of the product, and the relatively small waste resulting from its manufacture. New processes, such as combining plywood and plastics, are opening new fields for it every day, which have a definitive postwar future, such as in the transportation and prefabricated-housing field.

The Northeast has very few plywood companies within its boundaries, although its industries and industrial-household buildings are using woods transported for thousands of miles. Manufacturers should certainly investigate our local woods in view of producing general-purpose plywoods which should find an even wider utility in the postwar period, especially in the fields of boxes, crates, and houses. Along the same line, wallboards from wood waste should also be investigated as a help for the housing shortage.

PROSPECTS OF WOOD-WASTE UTILIZATION

While we have only touched on a few of the problems and possibilities of using wood which is generally wasted, their importance to the Northeast and the nation is obvious. The encroachment of other materials on fields of wood use is nothing more than the normal response of technology to the demand for new and better products at reasonable costs. The forest-products industry obtained a new lease on life on account of the war. However, now is the time to introduce adequate manufacturing techniques, utilize wastes, and develop new products. The pent-up demand for the products of the wood industry should not lull it into inactivity, as keen competition from steel, light metals, concrete, and plastics is again bound to come. Development work does not have to be revolutionary in nature. Thus a new wood-burning stove has been devised by a member of our council which is far more efficient than conventional burners. This proves that even in such an old art, an engineer can find ground for improvement. The cutting and sawing of wood is another example. The studies of Frederick Taylor resulted in far better methods of machining of metals. Unfortunately, similar studies have not been conducted on wood, although they may result in the development of better and more efficient tools, producing cheaper products. New manufacturing techniques with large outlets exist in the plywood field for using second-growth hardwoods and small logs in the production of utility grades. By the use of plastics, the uses of wood are extended. The conversion of wood waste into pulp and chemicals is a big field in itself which has made tremendous progress in recent years.

As pointed out by Dean George A. Garratt, there is urgent need for the application of adequate quality control and segregation throughout the entire manufacturing process. This applies not alone to the manufacture of improved forms of wood, intended for specialty purposes and requiring the application of more advanced processing techniques, but also to the production of lumber and other conventional items which

(*Continued on page 127*)

Comparison of CRUSH DRESSING *and* DIAMOND DRESSING

As Applied to Thread Grinding

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OUR interest in form grinding dates back to the year 1921, when our first diamond truing device was built for dressing 60-deg thread forms. Although this paper will confine the discussion to thread forms, it should be borne in mind that a thread grinder is really a form-grinding machine, and what holds true for threads will very likely hold true for other forms.

The recent interest shown in crush dressing has posed two questions: (1) Has the grinding-machine industry been wrong all these years in giving so much attention to diamond dressing devices? (2) Does the crush-dressed vitrified wheel displace the diamond-dressed resinoid wheel as the most efficient type for maximum stock removal?

CRUSHING METHOD NOT NEW

The records show that wheels have been formed by the so-called crushing method for many years, both experimentally and practically. As a matter of fact, probably this process was used in one form or another before the year 1921, when we started our first work in this direction, but the wheels thus formed were only a small percentage of the total number of formed wheels being used by industry. The diamond was really the accepted means of forming or truing a wheel into the desired shape. A wheel dressed by this means was accurate and dependable.

It should be remembered also that up to the early 1930's, form-grinding or thread-grinding was with a few exceptions considered as a finishing operation only. The largest users of grinding wheels for ground thread forms were the small tool and gage manufacturers who used them in the production of taps, thread gages, and in our case, in the grinding of chaser teeth for automatic-die heads.

Accuracy was the most important factor. Practically all work was brought to the grinding machines roughed out, an average of 0.015 to 0.020 in. being left for the grinding operation. In other words, any grinding operation in this period was considered as a rectifying job or a cleanup of the existing form. Most machines operated at relatively high work speeds taking light cuts. The material being ground was for the most part high-speed steel. This material was not hard to grind. It was well understood, and the wheel manufacturers were very successful in producing standard grinding wheels for the service they were called upon to perform. The only real problems that the manufacturer of grinding machines had to meet were those of finish and lead accuracy. These improved constantly through the years with the improvement of wheel spindles and machine design.

In the early 1930's, the aircraft industry demanded something better in the way of threads than could be produced by the conventional methods. They were large users of heat-treated alloy-steel parts and were demanding a quality of thread which could be made only by grinding. Reference is made to such parts as studs, crankshaft bolts, propeller shafts, cylinder barrels, etc. In order to meet this need, a thread grinder of modern design had to be produced. This required a machine that was massive and had ample power for wheel drive, required much larger wheels, and was semiautomatic in operation. These machines of new design no longer required that the work be prethreaded in most cases. A completely new technique in grinding from the solid was developed. Instead of using high work speeds and light cuts, low work speeds were used and very heavy cuts.

Simultaneously with this development came new types of wheels which were run at surface speeds often as much as twice as fast as the accepted normal of 6000 fpm. The combination of these new developments, together with an automatic wheel-truing device which removed all guesswork as to the thread form, made it possible to produce high-grade threads rapidly. This was true not only of aircraft parts on alloy steels, but was true also of the threads on taps and gages, and it became commonplace to grind the majority of these parts from the solid in one or two passes without the necessity of a prethreading operation.

In general, the grinding of tools and gages had tended to focus attention upon the preservation of the wheel shape. The developments, as outlined, took an opposite course considering the wheel as an inexpensive tool which would be allowed to wear rapidly, and concentrating attention on stock removal so that thread grinding might become a true production process. It is not desired to sacrifice accuracy in this process of making thread grinding a high-production operation. Refinement in wheel truing, and the development of automatic wheel truing and automatic sizing enable us to preserve or even improve previous standards of accuracy in thread grinding while greatly improving the output of the process.

Much was learned about the type of coolant which worked most effectively with grinding wheels, and the way in which this coolant should be applied. This in itself was an important step in the development of thread grinding on a production basis. The combination of large-diameter diamond-dressed wheels of the resinoid type with accurate control of the coolant in sufficient quantity to lubricate and cool the work effectively resulted in accurately ground threads in large quantity and gave them to us on a machine which was semiautomatic in operation.

The forms that we were called on to grind were of such a varied nature that a wide variety of truing devices were designed to take care of the particular requirements of the user. The need for accurate threads without sharp corners led to the introduction of a round top and bottom buttress thread, and the so-

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called electric thread similar to the thread used in lamp-socket work. All tolerances were so closely held that it seemed inadvisable to try to produce them in any other way except through the use of diamond tools. The large quantity of ground threads which were produced with diamond-dressing devices is proof of the fact that they met the situation and the needs of the war effort.

MULTIRIBBED WHEEL INTRODUCED

The closing years of the war saw the introduction of the so-called multiribbed wheel. This is a development which would naturally follow the perfection of grinding by the single-ribbed process. This greatly broadened the useful field for ground threads. It can readily be seen that if a 12-pitch thread 1 in. long is to be ground with a single-ribbed wheel, it will take much longer to grind than would be the case if it were ground with a multiribbed wheel which had 12 ribs working simultaneously.

Among the various diamond truing devices we had developed was one known as the multiform truing device. This device was built in 1939 and was used to produce various types of forms not related to threads, such as the special grooves which were required on the ends of valve stems, or special grooving operations on other types of work which would otherwise have been difficult to manufacture. One job to which it was well adapted was that of partial thread removal. Two wheels were mounted on one wheel adapter, one wheel to grind the thread and the second wheel to follow up and remove the partial thread at the beginning of the cut. It might be noted that this truing device was designed originally with the idea of using it on multiribbed threads but certain patents which we respected prevented us from using it on threads until late in the war. With the clearing of the patent situation we were in a position immediately to take advantage of our experience in the design of diamond dressing equipment.

The multiribbed truing device was immediately put to work on the type of job for which it was originally designed. One of the first important applications was that of grinding the taper threads on the ends of rock drills and tool joints for the petroleum industry. This thread was too long to be ground by a wheel as wide as the thread is long. However, it is a simple matter to produce a wheel which has three ribs; the first a rougher, the second a semifinisher, and the third a finishing rib. That 5-pitch thread is now ground from the solid in one pass. We were able to cut the grinding time to one third of the former milling time and, in addition, produced a very much more accurate thread of better finish.

In designing a truing device for diamond-dressing multiribbed threads, it has been found advisable to dress only every other rib. The reason for this is that it allows use of a more substantial diamond with which to form the wheel. This means that, where a thread is to be ground, it will be necessary for the work to travel 2 and a fraction revolutions rather than 1 and a fraction as would be the case if we were dressing every rib. We designate the two different methods as "skip-rib" and "full-rib" dressing. The multiform device was designed to operate efficiently in connection with the resinoid-type wheel which had proved to be the great production thread-grinding wheel during the war years. The threads ground by this process were immediately successful, were found to be well within the class III specifications, and the grinding speeds of $2^1/_2$ to 3 fpm on the work became standard. This type of truing device for multiribbed work has been widely accepted and is in use in many places throughout the country.

The use of wide wheels, up to 2 in. in width, requires considerable horsepower for driving the wheel spindle. It is not at all uncommon to use a 20-hp motor for this service. This motor is always a direct-current variable-speed type so that the proper cutting action of the wheel may be maintained under all conditions.

EUROPE FAVORED CRUSH-DRESSED METHOD

Wheel-forming by the crush-dressing process has been well-known for some time and has been widely used in Europe, particularly by the British. As a matter of fact, the two types of wheel truing were in competition in France before the war. At that time it was definitely proved that the superior equipment provided by American manufacturers could more than offset any advantage that might be gained from the multiribbed crush-dressed method. There was no difficulty in maintaining far higher production and greater accuracy with a single-ribbed diamond-dressed resinoid wheel than the European manufacturers could maintain with a crush-dressed multiribbed vitrified wheel. However, improved technique in the handling of crush-dressing equipment and the development of wheels which are adaptable to that form of dressing have again brought crush dressing to the fore. So far crush dressing must be confined to the vitrified type of wheel; not that it is impossible to crush-dress the resinoid type, but we have found that the time required and the wear on the crusher roll make it inadvisable at present. Hence practically all crush dressing as of today is confined to vitrified wheels and all of the subsequent crush-dressing tests which will be outlined in this paper were conducted with that type of wheel.

Since a variable-speed direct-current motor had always been used for driving the grinding wheel, it seemed advisable to use the wheel as the driving medium rather than the crusher roll as is usually done. In our case, we found by applying low voltage across the armature that we could obtain satisfactory low-speed control of the wheel spindle. The crusher roll was mounted on ball bearings, free to turn at whatever speed the wheel should happen to be turning. Rather than using a fixed in-feed, it was decided to use in its place hydraulic pressure feed which would allow the amount of in-feed to be varied according to the load. In other words, it was found possible to crush more rapidly in the first two thirds of the thread depth than in the last third, when almost the entire form is in contact with the wheel. This also provided an opportunity to determine exactly what pressures were best and to vary the load as the need should arise. This equipment was designed to go on one of our standard machines and was mounted directly behind the wheel spindle.

STANDARDS ESTABLISHED BY TESTS

The question naturally arose as to the ability of a roll to stand up under the crushing action. Experiments were conducted to determine under just what conditions we would get the maximum length of life out of a wheel-crushing roll by maintaining the accuracy of form. From an elaborate series of tests, the most efficient working speed for the grinding wheel was determined, and this has come to be accepted as standard for wheel-crushing operation. A 220-grit wheel was used, having a hardness range of K, L, or M. We found among other things that the form of the crusher roll was not materially altered as long as good contact under pressure was maintained between the roll and the wheel.

It might be well to point out at this time that the material used in the rolls was high-speed steel with a normal hardness range of 63 to 65. We also tried various pressures on the crusher roll and found that a pressure range of 100 to 150 psi worked best. This is in the neighborhood of 400 to 600 psi total pressure of roll against a wheel 1 in. wide, having the specifications previously noted. If more pressure than this was used, the crushing action would be faster but not as accurate. If less pressure was used, the crushing action proved to be slower, and

TABLE 1 COMPARISON OF TEST RESULTS WITH DIAMOND-DRESSED AND CRUSH-DRESSED WHEELS

Test no.	1	2	3	4
Diamond dressing				
Work diameter, in.	1.375	1.375	1.375	1.250
Work rpm	7	11	16	19.5
Work fpm	2.5	3.94	5.73	6.35
Wheel fpm	10000	10000	10000	13000
Grinding cycle, sec.	30	19	15	13
Dressing time per piece, sec[a]	0.5	0.55	1.2	0.41
Total grinding time, sec	30.5	19.55	16.2	13.41
No. pieces per dress	50	45	20	60
Length thread ground per rib per dress, ft[b]	44.75	40.27	17.9	48.06
Input horsepower	8.7	9.9	10.8	14.4
Input hp per rib	1.45	1.65	1.8	2.4
Machine used[c]	6 × 36	6 × 36	6 × 36	6 × 36

[a] Dressing cycle 25 sec; fully automatic.
[b] Based on a root grind of $2^1/_2$ turns per rib.
[c] 15-hp wheel motor.
NOTE: Wheel used A80T3BT5—skip rib—20 in. × 1 in. × 10 in. resinoid. Material ground, S.A.E. 1040; hardness C-28 to C-30. Thread length 1 in. Pitch 12-N.S.-3.

Test no.	1	2	3	4
Crush dressing				
Work diameter, in.	1.375	1.375	1.375	1.250
Work rpm	2.7	4.5	6	9
Work fpm	1.0	1.6	2.15	2.93
Wheel fpm	8400	8400	9100	10200
Grinding cycle, sec.	39	25	22	15
Dressing time per piece, sec[a]	0.22	0.66	0.78	1.1
Total grinding time, sec	39.22	25.66	22.78	16.1
No. pieces per dress	244	83	70	50
Length thread ground per rib per dress, ft[b]	131	44.5	37.6	24.4
Input horsepower	8.3	8.3	12.3	13.5
Input hp per rib	0.69	0.69	1.02	1.12
Machine used	6 × 15[c]	6 × 15[c]	6 × 36[d]	6 × 36[d]

[a] Dressing cycle 55 sec. Manual. Operator must give full attention to dressing operation.
[b] Based on a root grind of $1^1/_2$ turns per rib.
[c] $7^1/_2$-hp wheel motor.
[d] 15-hp wheel motor.
NOTE: Wheel used 38A220K9VBE—full rib—20 in. × 1 in. × 10 in. vitrified. Material ground, S.A.E. 1040, heat-treated to a hardness of C-28 to C-30 Rockwell. Thread length 1 in. Pitch 12-N.S.-3.

there was a decided tendency for wear to develop on the crusher roll.

It is not claimed that this series of tests gives us all the answers. We do believe that it does point the way toward increased production of ground thread parts and does show what may be expected from both crush- and diamond-dressed multirib wheels.

All the experimenting was done on a 12-pitch thread form. This is a popular thread which allowed reduction of the diameter of test blanks in $^1/_8$-in. steps, so that we could make repeated tests. It was also learned that considerably more wear results on the crusher roll during recrushing operations than takes place in the original crushing of the wheel. Experience finally indicated that the length of time that the crusher roll was in contact with the wheel on the recrushing operation was very critical. If not enough time is allowed, complete crushing is not obtained and a gradual build-up in relative size of wheel occurs, as compared with the work, which on a machine with automatic sizing means that size control is sacrificed as well as form. On the other hand, if the wheel and crusher roll are allowed to roll together a few seconds longer than is necessary, undue wear occurs and the crusher-roll form deteriorates rapidly. Therefore it became customary to time the recrushing cycle very closely. Under those conditions, it was found possible to recrush a wheel 50 to 75 times with almost no sign of wear on either the crusher roll or in the form of the wheel itself.

APPLYING THE CRUSH-DRESSING TECHNIQUE

Having determined the most satisfactory crushing technique for our type of grinder and spindle, we then started on the next phase of the job which was to run an actual grinding test on the samples. It so happened that we had a large supply of S.A.E. 1040 stock about $1^1/_2$ in. diam, which had been condemned by the inspection department because of deep rusting. We had these cut up into blanks about 4 in. long for the purpose of grinding a thread on each end. Most ground threads are heat-treated stock, so the material was given a heat-treatment, which resulted in a hardness of C-28 to C-30. After each grinding operation, the same material was turned down to the next size, that is, $^1/_8$ in. smaller, by means of carbide tools. We then set up two machines, alongside each other, one being equipped with a diamond-dressing device and a 15-hp motor driving the 20-in-diameter wheel. The other had a crush-dressing device and carried a 20-in. wheel driven by a $7^1/_2$-hp motor. At the beginning of the test it was assumed that $7^1/_2$ hp would be adequate since evidence seemed to prove that the crush-dressed wheel would cut more freely and that it would require less power.

A test run was made with the new equipment on the $1^1/_2$-in. blanks in order to obviate any difficulties which might develop around the new technique being introduced. Tests were started at the conventional work speeds for this class of work of 0.5 and 1 fpm. We found that the claims that a crush-dressed wheel would grind a large number of pieces between dressings was amply borne out by the experience. At 0.5 fpm, it was found that 240 pieces could be ground between dressings before the overload relays of the wheel motor stopped further grinding operations.

When tests were run at 1 fpm, it was found possible to grind 155 pieces before stalling the motor. These were rather phenomenal runs from the standpoint of the ability of a crush-dressed wheel to maintain its form. The time cycle was most unsatisfactory from the standpoint of production, in view of the fact that we had machines working in the field which were producing threads at a much higher productive rate than was the case of the crush-dressed wheels.

Having run out of samples at this point, it was determined to make a competitive run on the stock reduced to $1^3/_8$ in. diam, starting with work speeds of 1 fpm on crush-dressed wheels, and $2^1/_2$ fpm on diamond-dressed wheels. During these tests we made some other observations which are pertinent to the test. Besides giving the work rpm and the work speed in feet per minute, we gave the wheel peripheral speed, the input horsepower into the wheel motor, checked the number of pieces per dress, time cycle, the feet of thread ground per rib per dress, and the dressing time per piece.

RESULTS OF TESTS

In Table 1 it will be seen just how these tests worked out. On one side the samples being ground by the crush-dressed method are given, and on the other by the diamond-dressed method. It will be noted that at 1 fpm work speed it is possible to grind 244 pieces per dressing. In test No. 2 on crush-dressing, where the work speed has been increased to 1.6 fpm, 83 pieces were ground per dressing. In test No. 3 the work speed has been advanced to 2.15 fpm, at which speed we were able to get 70 pieces per dressing as against 83 on the previous test. The time cycle improved, as will be noted, from 39 sec to 22 sec per piece, but the amount of feet of thread, which could be ground per rib between dressings, dropped from 131 ft in the case of the first test to 37.6 ft in the case of the third test.

The input horsepower had, on the other hand, advanced from 8.3 to 12.3.

Now, turning to diamond dressing, it will be noted that three tests are entered; the first running at 2.5 fpm, the second at 3.9, and the third at 5.7. In comparing these tests, it is well to bear in mind that in crush-dressing only 1 and a fraction turns are required in order to complete a thread, while in diamond dressing 2 and a fraction are required because of the fact that we skip or dress out every other rib. It will also be noted in comparing the two, that high wheel speeds are used in the diamond-dress tests. This is because a resinoid-type wheel has been found to work better at the higher speeds. The time cycles with a diamond-dressed wheel start at 30 sec and go down to 15 sec. At the same time the input horsepower goes from 8.7 to 10.8. No. 3 test on crush-dressing, and No. 2 test on diamond dressing come nearly within the same production range.

In the case of the crush-dressed wheel, it will be seen that a time cycle of 22 sec was established, as against a time cycle of 19 sec in the case of the diamond-dressed wheel. The input horsepower on the crush-dressed wheel is 12.3 against input horse-power of 9.9 on the diamond dressed wheel; 37.6 ft of thread were ground per rib on the crush-dressed wheel, while 40.2 ft per rib were ground with the diamond-dressed wheel.

This would seem to indicate that there is a point beyond which more horsepower is required to drive a crushed vitrified wheel than is required to drive a diamond-dressed resinoid wheel, but the amount of horsepower required in either case need be of little concern if a motor of adequate horsepower is provided with the original grinding equipment.

It will be noted that the test No. 4 on both diamond and crush dressing was made on the $1^1/_4$-in. stock. In the case of the diamond-dressed wheel, operation was at a peripheral speed of 13,000 fpm. This was done in an effort to determine if the wheel could be made to operate at a work speed of 6.35 fpm. The grinding cycle was 13 sec, and a total of 60 pieces was ground between dressings. This test was run using a wheel speed higher than the safety rules will allow. It is of interest only because it indicates that somewhat better results might have been obtained on the diamond-dressing tests had full advantage been taken of the 12,000 fpm maximum allowable wheel speed.

No. 4 test on crush dressing was ground at the rate of 2.93 fpm and a total of 50 pieces were ground per dressing. The grinding cycle on this job was 15 sec. It will be noted also that the wheel speed had been increased to 10,200 fpm, which is quite high for a vitrified wheel but not beyond the allowable peripheral speed for the wheel used.

This brings us to a point where we can compare No. 3 of the diamond-dressed samples with No. 4 of the crush-dressed samples, except for the difference in diameter. No. 3 diamond-dressed wheel, which was run at a grinding cycle of 15 sec, ground 17.9 ft of thread between dressings and required 10.8 hp at the wheel motor. In the case of crush dressing for the same grinding cycle on a smaller-diameter piece, we find that 24 ft of thread were ground per dressing with an input horsepower of 13.5.

Small test runs were made with samples of other material such as high-chrome high-carbon steel, heat-treated to a hardness of C-62 to 65; also water-hardening tool steel at C-66. In both cases the grinding results were satisfactory for either crush dressing or diamond dressing. These materials, because of their greater hardness, required more input horsepower at the wheel motor.

SUMMARY OF TESTS

In summing up, we believe that diamond dressing has the following advantages in so far as our experience goes:

1 We believe that it is easier to set up for multiribbed grinding with a diamond truing device because there is only one diamond and one former. The diamond is accurately and rigidly held in place, and resetting the diamond tools does not disturb the over-all setup to any great extent.

2 Diamond dressing also gives a greater average accuracy in this type of grinding. The diamond maintains a better form on the wheel because wear is relatively small, and the inaccuracies produced by wear are of little consequence.

3 A diamond-dressed resinoid wheel also produces a better average finish than can be obtained from a crush-dressed vitrified wheel. This is due to the burnishing or polishing action that seems to be inherent in the grinding action of the resinoid-type wheel.

4 The diamond-dressing device will also allow the user to grind finer pitch threads than seems to be possible by the crush-dressing method. There is no difficulty in obtaining 40-pitch basic form with this type of dressing. If required, it is probable that one could go even finer. It is doubtful whether a basic form finer than 20 pitch can be produced by crush-dressing, at least as a commercial proposition.

5 The diamond-dressing device also lends itself to the automatic-machine cycle far better than does the crushing operation. The crushing operation is in itself rather complicated and, although it is possible to conceive of complete automatic operation, the controls that would be required would seem to make it impractical at this time.

6 A diamond-dressed wheel will also give better size control over repeated dressings than will the crush-dressed wheel. By this we mean that, although it probably is possible to crush-dress repeatedly and still stay within class III pitch-diameter tolerances, it is found that the variation in size due to repeated dressings is much less with diamond dressing than with crush dressing.

It might be well at this point to touch on the relative cost of diamond tools versus crushing rolls. The average diamond tool used for this type of dressing costs $18 to $20. This tool, according to tests which we have recently run in our plant, should produce from 100 to 150 dressings before it becomes worn enough to be returned for relapping. The diamond suppliers assure us that tools of this type should be capable of being relapped three to four times. We do know that diamond tools which have been used in this class of work have not stood up as well as the figures just given. On the other hand, we find that the suppliers in submitting tools for tests can almost invariably provide us with tools that will stand up to the specifications given. This being the case there seems to be no real reason why all the tools supplied should not give as high average performance for general use as they do for testing purposes. If they do not, they then encourage the user of ground-thread equipment to go to the crush-dressing method as one form of relief from diamond trouble.

It should be possible to manufacture master crushing rolls 4 in. diam with $2^1/_8$ in. width of face to sell for less than $100. These master crushing rolls can and will be used for dressing wheels from which working crusher rolls are made. A great many working rolls can be made from one master if the correct procedure is employed in grinding the threads on the blanks. This would mean, of course, that working crusher rolls can be made much more cheaply than the masters. The working crusher roll would start with a disadvantage over the master crusher, there being slightly less usable life in the crusher roll than would be the case if a master roll were used for each job.

Table 1 indicates the approximate number of pieces that may be expected per dressing from a crushing roll. The point at which a crushing roll becomes no longer usable rests with the user. We have found a wide variation of opinion as to what

constitutes a good class III thread. If the full wear tolerance on class III threads is used and some allowance made for slight changes in form on the flanks due to wear, it is possible that even more crushings can be obtained than we have found to be possible according to the standards we have set up in our own plant.

ADVANTAGES CLAIMED FOR CRUSH DRESSING

The arguments on the advantages of crush-dressing are presented as follows:

1 Crush-dressing gives a greater angle range than is possible with the diamond-dressing equipment. The multirib diamond truing device can dress any thread form which has a flank angle greater than $22^1/_2$ deg as measured from the vertical. That means there are certain types of threads such as worms, acmes, buttress, to mention a few, which cannot be done by diamond dressing. Some of these, however, can be taken care of by crush dressing which device will allow going within 5 deg of the vertical in so far as flank angle is concerned.

2 With proper technique, a new wheel can be crushed to form more quickly than it can be diamond-dressed to the same form. This is because of the fact that the full width of the face is being worked in the crushing operation whereas the diamond must travel back and forth across the face taking relatively light cuts.

3 We find that there is less tendency to discolor the work when using a crush-dressed wheel than when using a diamond-dressed wheel, although this discoloration is largely due to carbonization of the grinding oil and has seldom been found to be injurious to the material. It is a matter which frequently causes comment when ground threads made by both processes are inspected.

4 The crush dresser does allow the crushing of full-ribbed wheels which means that the work need not rotate as rapidly in order to produce a finished piece in a given length of time as is the case with a resinoid-type wheel, which is dressed by the skip-ribbed method. However, on that class of work where full ribs can be dressed on the resinoid-type wheel, this again becomes the faster producing wheel.

There are a few disadvantages in the use of crush dressing which do not appear in diamond dressing. We have learned, for instance, that the crushing roll must be carefully centered on the grinding wheel, making certain that no partial thread is crushed into the edge or corner of the wheel. This leads to flaking which may materially alter the sides of the wheel if not taken care of immediately. We have found also that any variations in the hardness or density of the wheel structure have a marked effect on the way the wheel crushes, and, as a consequence, on the finish ground on the work.

CONCLUSION

In summing up, we will go back to the two questions that were raised at the beginning of this discussion. The first was whether the grinding-machine industry had been wrong all these years in giving so much attention to diamond-dressing devices. In this respect the answer is: Definitely no, because no form of crush dressing will give the accuracy and the finish that can be obtained by diamond dressing. There are many jobs where accuracy and finish are of prime importance. All master crusher rolls, for instance, will have to be formed by the diamond-dressing principle.

The second question raised was whether the crush-dressed vitrified wheel displaced the diamond-dressed resinoid wheel as the most efficient type for maximum stock removal. Our answer to this is that it does become a real competitor with the resinoid wheel in multiribbed thread-grinding. Table 1 shows that it has certain characteristics which make it advantageous to use this type of wheel on multiribbed work, where the specifications are class III or less accurate. In our experience it has seldom been found advisable to run a vitrified-diamond-dressed wheel faster than 7000 to 8000 fpm. This limits the work speed so that we have never been able to equal the performance of a diamond-dressed resinoid wheel on single-ribbed work. The diamond-dressed resinoid could run at 12,000 fpm with a consequent increase in work speed which would carry it far ahead of the vitrified type.

It can be seen from the chart which summarized our experiments that we are now able to run vitrified crush-dressed wheels at higher surface speeds than formerly. This allows an increase in the work speed to such an extent that it really puts the vitrified wheel in competition with the resinoid type. However, the diamond-dressed resinoid wheel still is able to grind at a higher work speed than we have been able to grind so far with the vitrified crush-dressed type.

It is felt that too much stress has been placed on the large number of pieces that can be ground per dressing with crush-dressed wheels and not enough on the greater number of pieces that could be produced at higher work and wheel speeds. Furthermore, until now no effort has been made to compare crush-dressing methods with diamond-dressing methods. The author has attempted in this paper to correct the deficiency.

Problems in Utilization of Wood Waste

(Continued from page 122)

will continue to serve as the backbone of the forest-products industry only so long as they are able to satisfy consumer demands in a highly competitive market. When the truck-body parts, fabricated from poorly seasoned stock at a mill, cannot be used at a different assembly plant because of warping in transit, the producer not only loses a customer, but the entire industry may lose a market. The manufacturers of competitive materials will be quick to take advantage of such an opportunity to promote their own products at the expense of wood.

The special requirements of numerous wartime products called for the establishment of new standards of precision in many woodworking industries. For many purposes, the micrometer has replaced the $^1/_{16}$-in. rule. Dean Garratt again states that it would be a step backward if these standards were disregarded in peacetime production. The success of prefabricated units, for example, is dependent upon uniformity of manufacture. Interchangeable units can be fabricated from wood, if manufacture to close tolerance is carried out by careful processing and technical control of all manufacturing operations. Adequate quality control implies the proper handling and processing of the wood in all stages of production, from log to finished product. It involves accuracy of sawing and other machining steps, establishment of adequate defect limitations, satisfactory seasoning, and proper control of gluing, and other techniques required in processing the product involved.

The conviction is growing in the lumber industry that its future prosperity may depend much upon carrying manufacture as far as possible, thus getting away from the low price level which is almost universally associated with basic materials. This will involve careful integration and will create a true forest-products industry. Research may transform wood into a raw material analogous with our conception of mineral ores and suitable for the production of a large family of forest products.

Through the use of heretofore wasted materials and the diversification and improvement of products, and their adaptation to standards of the modern industrial age, the forest should remain among the greatest of America's possessions in the future as it has been in the past.

Shall We Fight or Welcome

FOREMEN'S UNIONS?

By JACK WOLFF

JACK WOLFF AND ASSOCIATES, NEW YORK, N. Y

ON THE surface it looks as if we must fight the unionization of foremen. There is widespread fear that if we lose it may be a blow from which our free-enterprise system will never recover. General Motors, the National Association of Manufacturers, and others have been fighting hard to enlist management and Congressional support for the principle that supervisors are a part of management and therefore cannot be unionized without destroying the effectiveness of management.

Some of the most vehement antagonists of the foremen's-union principle have, however, overlooked this key point: When we fight, mistrust, or ignore the foremen, we are welcoming a union of foremen. We can welcome a foremen's union through the front door—or we can welcome it through the back door.

They enter a wide-open back door because we fail to treat our foremen as potent and creative members of management. In spite of beautiful words and sentiments, far too many of us have been treating them like simple straw bosses. We have hired them young, treated them rough, and told them next to nothing.

TWO SIDES TO THE FOREMAN QUESTION

This production bottleneck, for that is what it is, calls for research and analysis. We won't get the answer if we are guided by prejudice and blame the other fellow for everything that is wrong or if we blow our tops. We must be as coldly objective in our analysis as an engineer figuring stresses and strains. If we go along fooling ourselves in the coziness of one-sided discussions, our structure may look awfully pretty through rose-colored glasses, but it won't carry the load!

We have heard but little of the other side of this question. It has not been publicized in comparison with the position taken by the automotive industry. The hue and cry has been almost overpowering that management will not long be effective if the majority of its members belong to unions and are subject to the control of union officials particularly if the foremen should belong to the same union to which their operating employees also belong.

We are familiar with the fact that people, like animals and birds, scare easily. At home we have some bird-feed boxes in the garden. A dozen or more birds swoop down to the feed-boxes and to the spilled seeds on the ground. They remain until one bird rushes into the air and heads for the protective bushes. Instantly all of the birds, or nearly all, rush into the air and head for the bushes. Even among the birds there is occasionally one who does not scare easily. The moment the other birds rush for cover this one throws up his head and carefully scans everything in sight. If he himself sees no danger to interfere with his dinner, he continues to eat while the other birds watch him enviously. After a few moments the others swoop back and try to catch up with him.

Human beings, even members of top management, are not too far removed from this tendency to rush for cover the moment some jumpy person yells "look out" and runs. In 1940 I had lunch in San Francisco with the vice-president in charge of personnel administration for the Pacific Telephone and Telegraph Company. It was during the time when a national association was pushing the idea of testimonial dinners in honor of company employees with forty or more years of service. He was irritated because within a few days he had been called on the phone by a dozen or more San Francisco Bay business and industrial men who wanted to know how he felt about participating in this plan. He told them that what he thought shouldn't make a particle of difference to their plans about their own employees. He said P.T. & T. was going to analyze its own situation and act accordingly and that they should do likewise; that he was not in a position to advise others concerning their position because he wasn't posted on their particular circumstances. Then he added, "It constantly amazes me how many important businessmen are afraid to make up their own minds. They call up everybody else to learn what they are going to do. I suppose they follow the majority lead, even though it may be against their own best interest."

As is well known, Henry L. Gantt said, "If we allow ourselves to be governed by opinion where it is possible to obtain facts, we shall lose in our competition with those who base their action on fact."

With all of this controversy concerning the awful things that will happen if foremen are unionized, I have failed to find any references to actual facts based upon experiences of a sufficiently wide nature to prove that the unionization of foremen will spell disaster for management. So far as I have observed, it is a series of opinions and dire forecasts which have been quoted and pyramided in support of this bitter fight against the unionization of foremen. The very bitterness of this fight is already building a stone wall between those top managements and their supervisors. It is also preventing a logical and objective analysis of the situation. This always happens when the main consideration swings over to "who's right," instead of "what is right."

MANAGEMENT HAS A CO-OPERATIVE RESPONSIBILITY WITH ITS SUPERVISORS

Please don't jump to the conclusion that I am trying to say that foremen should be unionized. Nor am I trying to say that they should not. From my work in nearly all parts of this country with foremen who have belonged to unions, even to the same unions with their subordinates, and also from my work with foremen who were not unionized, it has been demonstrated repeatedly to me that production is affected very little by the union or nonunion status of the foremen. It has been demonstrated over and over again, however, that the one influence far above all others on the effectiveness of the super-

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visory force in any organization is the intelligence with which top management lives up to its exceedingly heavy co-operative responsibility toward the supervisors who are supposed to be its fellow-management members.

We laugh at the story of Don Quixote who took on the windmills of Spain. He fought them hard and pointlessly, with everything he had. But before we laugh too hard, we'd better ask ourselves whether "unionization of foremen" doesn't have quite a few windmill characteristics. Let's get down to basics. Why do we have supervisors in industry? Is it to fight them? We are told their purpose is to help management improve production and increase the profits of the corporation. In fact, we are told that they are part of management. The supervisors are told they are part of management. Newspaper and magazine advertisements and articles insist that supervisors are part of management. It is almost as though a thing will become a fact if we claim it long enough and loud enough, like repeating for generations that the Emperor of Japan is the direct descendant of the sun goddess.

No matter how many times top management repeats and repeats that its supervisors are a part of management, if they are not a part of management, the supervisors, in spite of hell and high water, will be the first to recognize that management is making false claims. Instead of helping its influence with its supervisors, management thereby brings about a deterioration of the top management-supervisory relationship because the supervisors are then convinced that management is not only incorrect in its assumptions, but that it is actually dishonest. Once the supervisors are convinced that management is playing them for suckers they no longer are interested in doing their utmost to "strengthen management teamwork," as the National Association of Manufacturers has so aptly put it.

SUPERVISORS SHOULD PARTICIPATE IN MANAGEMENT AFFAIRS

If supervisors are to be classed as management members and are to become interested primarily in management affairs, it becomes imperative for top management to bring them into the management circle by calling upon every supervisor to help observe, analyze, and solve current management problems. This call for the supervisors' help still won't do the trick unless management at the same time sets up a mechanism through which each foreman will be stimulated and will be enabled to develop his skill and the deeply rooted habit of observing, analyzing, and solving management problems. How to set up such a mechanism is a large subject in its own right.

Many demonstrations in factories and commercial organizations throughout this country and England prove that supervisors do perform profitably as actual management members. They participate in the actual formation of operating policies. They are deeply interested and highly effective in improving the quality and the quantity of production and the steady reduction of unit costs. Those foremen, incidentally, are not hell bent on forming or joining a union. They are getting their full measure of satisfaction from their constructive and creative work on the job. Those top managements are reaping the benefit of their foresight in setting up an operating plan that encourages and profits by his constructive co-operation.

Where management makes it possible for its supervisors to participate actively in management affairs, they lose interest or fail to become interested in foremen's unions. Those supervisors don't need unions because they already have the ear of top management on any subject they want to bring up. On the the other hand, if in spite of management's contention that they are members of management, the supervisors feel they are not members of management, that they are only straw bosses who must do as they are told, and who far too often have been reminded that the brains on the top floor do the thinking, supervisors in such corporations will be driven to the desire and eventually to actual unionization because they feel frustrated on the job. They are treated with disdain, frequently bordering on contempt, by their executives and are put on the defensive so consistently that if they have any guts at all, they generate within themselves such a powerful desire to be heard, to be listened to, that they will unionize so they can force the company management to listen.

WHY SHOULD A SUPERVISOR "STICK HIS NECK OUT?"

There are countless occasions which show that the inherent ingenuity and initiative of supervisors have been crushed until they bite off their tongues before they'll help management improve operations. They realize clear down to their toes that they are not a part of that management. An oil company supervisor once told me of being in the mailroom of the home office when a young messenger boy dumped three heavy packages on the counter. "These go air mail." The head mail clerk reached into his cage and pulled out a bunch of high-denomination stamps which he plastered on the packages.

The supervisor gasped, "how much money is tied up in those stamps?"

"About twenty dollars."

"By whose authority do those packages go air mail?"

"Search me."

"You mean to say a messenger boy can just say 'air mail' and you put out twenty bucks of company money? Why the kid's boss might have told him to send 'em parcel post!"

"Sure. Hundreds of packages and letters go out of here every day by air mail—and they'd be delivered next morning at exactly the same time if they went regular mail."

"Good Lord!" The supervisor did some silent thinking and suddenly asked, "Have you any idea how much money the company throws away on unnecessary airmail postage?" The head mail clerk started figuring on the side of a package. "It runs about $2500 each month."

The supervisor was speechless, thinking how he was held down on every purchase of one dollar or over. "That's 30,000 bucks a year! Why don't you report that upstairs?"

"I'm not sticking my neck out!"

When the supervisor had finished telling me the story, I asked, "Have you told some of the big boys about this?"

"Who—me?" He looked startled. "No! I'm not sticking my neck out either!"

Did those two supervisors consider themselves a part of management? And did their executives have their confidence?

UNIONIZATION OF FOREMEN DOES NOT SPELL DISASTER

Management, through its intelligent treatment of supervisors, can make it extremely difficult, if not impossible, for union organizers or individual supervisors to unionize foremen. If its treatment of its supervisors is less than intelligent it can, and usually does, encourage its supervisors to unionize. But even though supervisors do form or join a union, that need not spell a weakening of the management function. We are inclined to fear that foremen who are members of a union will become creatures of the union local's officials, that they will divide their allegiance between the union officials and the company executives. We immediately think of the admonition in the Bible that man cannot serve two masters. But we fail to recognize that the union members as a group can control their officers. If they are intelligent union members they may be influenced by those officers when those officers are intelligent leaders. But when they consider their union leadership contrary to their own best interest they can quickly bring about revolutionary changes. Incidentally, some old-time union lead-

ers have been heard to urge caution on trying to organize foremen because the well-trained foreman mind will present a lot of new problems. Foremen can't be handled like the men who work for them are. So management has some unexpected allies on its side, at least they both see possible headaches in the unionization of foremen.

In the early part of 1941 the Moore Dry Dock Company in Oakland, Calif., had received what, at that time, seemed an enormous contract from the Navy. They were called upon to rebuild some luxurious C3 passenger and freight liners into submarine tenders. Instead of a normal amount of electric wiring, for example, including lights for the top-deck swimming pool, they had to install radar, ordnance fire-control apparatus, intercommunication systems, degaussing switch panels, and the regular marine electrical installations.

The entire shipyard was due to expand from less than 2000 employees to about 7500. The department with the biggest individual expansion was the electrical department. At that time it had some 30 supervisors from leadmen up to the general foremen and no more than 60 or 70 full-time electricians. Some of the supervisors frequently had to work as journeymen. Whenever a new repair job entered one of the dry docks they might have to hire 50 or 100 of the marine electricians who customarily rotated among the repair yards in the San Francisco Bay area.

I discussed the expansion problem with the general foreman and asked him to assign a committee of fifteen to eighteen of his supervisors at every level of supervision to the job of working out plans for the personnel expansion of his department which was expected to reach about five or six hundred people. During the early stage of planning for this expansion some of these supervisors—and they were all members of the International Union of Electrical Workers—decided that certain union rules would prevent the shipyard from expanding fast enough to handle the work which was coming in.

One of the supervisors said, "Let's invite our business agent to tomorrow's meeting." The group agreed it was a good idea. The following day the business agent and two international representatives appeared in one of the shipyard's conference rooms.

We had barely got started when one of the international officers said, "We believe this company is making a mistake to go ahead with these plans to recruit and train electrical workers and supervisors without discussing it with the union first."

As the conference leader, I tentatively admitted our oversight, but added that we had considered this group of eighteen supervisors as union representation because they were all members of the union and they were doing all the planning.

The international representative looked at the group and waved his hand around the table, "That's all right—I hadn't realized this situation when I spoke. The union is completely satisfied with the way you are preparing for this expansion."

A few moments later when the group was in the midst of a serious problem, one of the supervisors spoke up, "I think we should get our officials to discuss the reasons for some of the rules that are going to keep us from doing what we've got to do."

I reminded them that it was completely up to the union officials as to whether they wanted to enter the discussion or answer any questions. They signified their complete willingness to co-operate, so the supervisors who were all members of that union started in on the specific union rules that were the bottleneck.

The discussion was getting quite hot and heavy when the business agent looked around the table and said, "Listen—the changing of these rules is up to the executive committee and the majority of the executive committee is sitting right around this table."

A supervisor swung in instantly with the suggestion, "Let's go into executive session!"

Once more I deferred to the wishes of the union officials. When they gave their assent, I told this highly paid group of shipyard supervisors, together with the union officials, that I would withdraw from the conference room, that they were welcome to use the room as long as they desired. Within two hours they called for me and reported that the union rules and regulations had been changed so as to make it possible for the Moore Dry Dock Company to proceed with its expansion in the electrical department.

Had the industrial-relations department of the shipyard or the shipyard's president negotiated with the unions to bring about these changes in union rules and regulations, it is questionable whether they would have been changed as completely or so quickly—or at all. It would have been much more difficult and perhaps impossible to get that union to sidetrack principles for which it had fought bitterly in years gone by in order to meet the employer's requirements had not these foremen carried the ball during that session between the unionized foremen and the union officials. Meeting on shipyard premises, on company time, the union's own executive committee acted as mighty effective representatives of the company.

FOREMEN CAN INFLUENCE UNION ACTION

That is an illustration—one of many—to show that company supervisors can be members of the union—even members of the same local to which their employees belong—and not only remain loyal to the needs of the corporation, but at the same time use their influence with the union or their official positions within the union to change union regulations so as to enable the company to increase its production. In this particular case the electrical department expanded from approximately 100 regular employees to more than 5000 within two years, and the yard expanded from less than 2000 to nearly 40,000 employees. It would not have been possible without the help of those 18 electrical-department supervisors who served on that committee and who acted as true members of management.

Incidentally, those supervisors stayed with the company throughout the war, were moved to the top of the department staff, and remained in the union as highly influential members. The top management of that shipyard had called upon them for help in observing, analyzing, and solving some extremely serious production and personnel problems. The top management had set up a schedule of production conferences, not only with those supervisors but with all the supervisors in all the departments to help the company observe, analyze, and solve its yard-wide production and personnel problems. These men had responded with an eagerness and intelligence that might amaze us if the results were not always the same whenever management calls upon its supervisors for managerial help and at the same time, sets up a mechanism through which that help can be rendered and through which the supervisor's planning is applied and brings results.

This same formula of calling upon and at the same time enabling an entire supervisory force to aid management in the observation, analysis, and solution of operating problems, will always bring the same beneficial results if it is effectively done, regardless of whether the foremen are or are not unionized.

The situation confronting top management is not whether it should or should not fight the unionization of foremen. If it fights their unionization, it will alienate many, if not most of its foremen regardless of whether the foremen win their fight to unionize. Instead of getting its foremen on the same team,

(*Continued on page 144*)

OUR FUEL SUPPLY—
A LOOK AHEAD

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INTRODUCTION

When it is recalled that steam coal of good quality sold at 25 cents or lower per ton f.o.b. cars at mines in West Virginia in years before the Guffey Act, and fuel oil sold as low as 40 cents per bbl ex-lighterage in the New York area during the depression period, the corresponding present prices of $4 or more per ton and $1.92 per bbl pose the question as to what sort of fuel costs should be expected in the years ahead. Many will be considering that question in order to reach a decision as to policies to be adopted relative to ways and means of reducing fuel expense.

Because of the number of factors involved, including groups of opposing tendencies, the problem is not a simple one and no one can predict with any certainty when, how, and to what extent fuel costs will change. In this paper, the principal factors which may be expected to influence prices of fuels will be discussed briefly. The author will not attempt to make any definite forecast. Conditions along the Atlantic seaboard will be referred to principally in the discussion of the subject.

Factors influencing prices for the several fuels to be mentioned may be divided into three main groups, (*a*) physical, (*b*) political, and (*c*) economic, and will be thus considered. Their interdependence will be evident.

OIL FUEL

The demands of the war period called for the production of refinery products at rates never previously attained in this country, and it was predicted that with the cessation of hostilities our requirements would shrink and thereby lessen the drain upon our crude-oil reserves. On the contrary, demands have been so sustained that stocks of crude have been reduced and crude-oil prices have been raised. Probably they will be further advanced in order to stimulate production as well as to cover rising production costs. Furthermore, the oil industry predicts expanding markets for its products in the years ahead.

With the expected expansion in market for motor fuel and for light oils, which are the most lucrative products, refining practices at those refineries serving the eastern half of the country are undergoing marked changes. The over-all effect of these changes is to increase the proportion of lighter oils and lower the percentage of residual oil per barrel of crude run. Whereas in prewar years refineries produced as light oils about 13 per cent of the crude run or only about 1 bbl of distillate oil to 2 of residual, in the future these proportions may be approximately reversed, except on the West Coast. Therefore we may expect supplies of light oils to be more ample than those of residual, for California's relatively larger production of residual oil is not likely to be economically available for East-Coast use.

This does not mean that supplies of residual oil available for East-Coast use will be limited to those derived from refining of domestic crudes. Imports of residual oil from Caribbean sources may augment production from our own refineries, and eventually imports of crude or of residual from the Middle East may bolster our supplies. In fact the experience of the late war may create sentiment favoring importation of oil to conserve our own resources.

The extent to which these foreign oils will supplement products obtained from domestic crudes may depend as much upon political factors as upon their physical availability. As for the Middle East, the question as to who will ultimately control those fields is still unsettled, but Russia's ambitions in this direction are no secret. When and as there is a recession in demand for bituminous coal, both producers and mine labor may endeavor to discourage or prevent importation of foreign oil by imposition of prohibitive duties or by other means, so as to preserve coal markets.

The economic factors affecting prices of light oils differ from those influencing residual oils, although rising production costs are common to both types because of higher crude-oil prices and mounting wages affecting production and distribution costs. Markets for light oils are expanding as a result of increasing use of Diesels and a growing consumption for heating. In the past the demands for heating purposes have accounted for about 70 per cent of light-oil consumption (including kerosene), and this proportion is expected to rise as total demands for light oils increase. We may logically expect therefore that the market for heating oils will largely determine prices for the light fractions, and will be influenced by costs of the better competitive fuels; gas, and anthracite coal.

Gas will doubtless be the principal competing fuel because of the inconveniences attending use of a solid fuel. Although some increase in prices of light oils is not unlikely, the stability of heating-oil demands makes this business attractive, and the oil interests may advisedly pursue a policy of keeping consumers' costs relatively stable, avoiding rises that will invite competition from other fuels.

As for the heavier or residual oil, the aforementioned changes in refinery operating trends seem to warrant the expectation that, in the future more than in the past, its price will be determined by competition of bituminous coal at points on or near to the Atlantic seaboard, with recognition given to the various advantages which may attend use of oil in place of coal. Although in periods of business recession there may be temporary weakening of prices, the basic changes, already effected and in prospect, hold out little hope for conditions of oversupply of residual oil such as have been witnessed in the past and have made it possible for users to buy at prices far below the com-

Presented at a meeting of the Metropolitan Section, New York, N. Y., November 6, 1946, of The American Society of Mechanical Engineers.

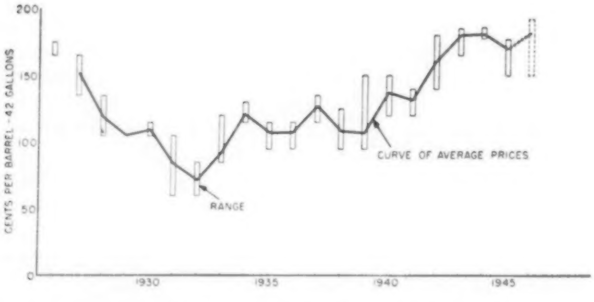


FIG. 1 PRICE OF BUNKER C OIL NEW YORK HARBOR, EX-LIGHTERAGE

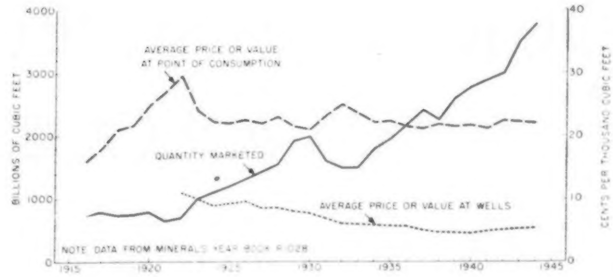


FIG. 2 NATURAL-GAS CONSUMPTION AND PRICE

petition afforded by available solid fuels. The generally rising trend of prices in the New York area since 1932 is shown in Fig. 1.

GAS FUEL

The growth in demand for gas for house heating, not only in areas where natural gas is available but also in territory served with manufactured gas, is generally known. Popularity of this means of heating is increasing and was strikingly illustrated by published results of an analysis of applications covering over 600,000 units filed under the Veterans' Emergency Housing Program. In New York, New Jersey, and Pennsylvania, the so-called Middle-Atlantic states where three-quarters of all anthracite is consumed and where anthracite is still the principal fuel for domestic heating, 46 per cent of the applicants wanted gas heating, 32 per cent wanted coal, and 22 per cent indicated preference for oil.

Other surveys made by publishers and by oil interests show a similar disposition on the part of householders to favor gas or oil in preference to coal. Those who now use oil or gas generally report satisfaction therewith whereas those using coal, even when mechanically stoked, indicate a desire for one or the other of the more convenient fuels. The lowered annual fuel consumption required for heating modern insulated houses today reduces the dollar premium to be paid for the convenience of gas or oil heat as compared to solid fuel, and partly accounts for mounting sales of oil- and gas-heating equipment. If the preference indicated by this analysis of veterans' applications, received in the first half of 1946, is typical of the thinking of future home owners, it is evident that salesmen for light oils and burner equipment can expect real competition from gas. The sale of gas for heating will be given further impetus if proposed plans for bringing natural gas into this populous area by means of the "Big Inch" and "Little Big Inch" pipe lines are carried through.

Even the use of gas in East Coast power plants to some extent may result if natural gas is transmitted through these big pipe lines, for some off-peak sales for steam generation may be economical in order more fully to utilize the capacity of the lines. Such gas would probably sell on some such basis as that mentioned for residual oil.

For the country as a whole, the marketed production of natural gas, as shown in Fig. 2, has increased about fourfold in the past 20 years, until in 1945, the quantity used was equivalent in heat content to some 165,000,000 tons of coal. Furthermore, over this 20-year period, the average value at points of consumption has shown a slightly declining trend.

What the future trend of natural-gas price will be will depend partly upon the prices of other fuels, but in those areas where most of the national consumption has occurred the price has been determined by the expanding supplies of gas-seeking markets. Over a period of years, it may be expected that prices of natural gas at the wells will rise, and this change will be reflected in a higher price being paid by the consumer.

ANTHRACITE COAL

Anthracite is and must continue to be primarily a domestic fuel because its production cost precludes general use of any but the small or steam sizes for power-plant use. Its production reached an all-time high in World War I, then dropped, and during the depression amounted to less than one half the wartime record. In World War II its use was again boosted but to less than seven-tenths of the record high. Producers are faced on one hand with rising costs and on the other with increasing competition from other fuels for domestic heating and have long realized their difficulties. It would appear that their salvation must lie along the line of devising cheaper ways of mining and of promoting automatic stoking and handling of ashes so as to meet the user's demand for convenience, but this second line of effort means increased use of small sizes for domestic heating.

Fig. 3 shows graphically the relative circular prices as of today for the more important sizes of anthracite, and the corresponding prices for 1924, 1937, and 1945. The sizes larger than buckwheat constitute about two thirds of total shipments and must carry the smaller sizes which sell below average cost of production. Prices of all sizes have risen, but the small sizes have shown greater rise percentagewise than the coarser sizes.

In so far as marketers of anthracite can increase sales of buckwheat, rice, or barley sizes to domestic consumers without causing a corresponding loss of tonnage of coarser sizes sold, the position of the industry will be sustained or bettered, but each rise in price of coarser sizes only encourages abandonment of their use. In the past, as production costs of anthracite have

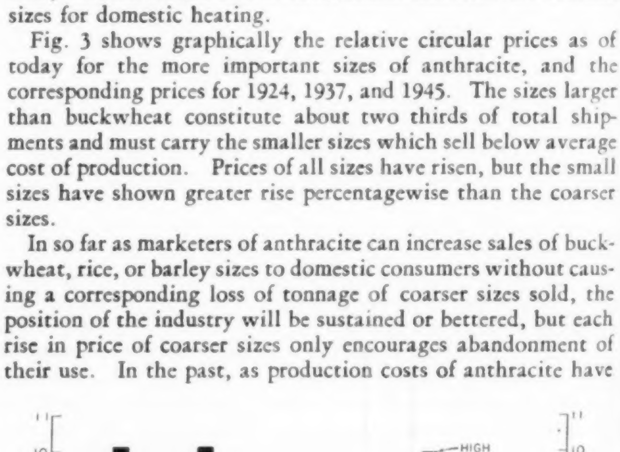


FIG. 3 CIRCULAR PRICES FOR ANTHRACITE COAL 1924, 1937, 1945, AND TODAY

increased, the so-called domestic sizes have borne most of the increase; in the years ahead, and particularly as culm-bank supplies are exhausted, it appears that this may not be true to the same extent.

BITUMINOUS COAL

By far the most important fuel in both the Middle-Atlantic states as well as in the country as a whole, from the standpoint of aggregate consumption, is bituminous coal. In New York and nearby states its movement in the retail trade is relatively small, although over the country the retail sales constitute about one fifth of the total tonnage. As to adequacy of supply, there should be no difficulty except as labor troubles result in prolonged idleness of the mines, or other conditions temporarily interfere with movement of coal. It has been estimated by some that for several years the level of industrial activity in this country will continue high and call for supply of 550–560 million tons of bituminous coal per year. To meet requirements of this magnitude calls for an average weekly production of slightly under 11 million tons, whereas in recent months, under 6-day-per-week operation, outputs of over 13 million tons have been recorded. In 1944, production amounted to almost 620 million tons or nearly 12 million tons per week.

It is certain that bituminous consumption in 1946 will fall well under this estimated postwar requirement, probably around 500 million tons. There are competent observers who view the immediate future less optimistically. Dr. C. J. Potter, formerly head of the Solid Fuels Administration and now engaged in the coal business, has estimated that the 1947 requirements will probably be met with 5-day operation of the mines, meaning an annual output of around 500 million tons, and that in the coal year beginning April 1, 1948, demand will amount to about 460 million tons.

Fig. 4 shows that if we exclude the years of World Wars I and II, our annual soft-coal production has been under 550 million tons in each year of the past thirty, except three; one of these was 1926, when English mines were closed by a long strike and our export business was stimulated thereby.

There are other indications of a feeling that supply is catching up with demand in the soft-coal business. Months ago John L. Lewis argued that Congress should pass another Guffey Act, evidently foreseeing the approach of the time when coal could no longer sell for "ceiling" prices but might need a "floor" below which coal could not fall. His most recent demands for a revision of the contract signed by Secretary Krug and himself may also be taken as an indication that he sees the period of continuous 6-day operation of mines coming to an end and wishes to do something to avert a reduction in the miners' weekly "take-home" pay.

The high coal prices prevailing today also have their effect in contributing to diminished consumption in that they provide a real incentive to improve efficiency of utilization. The experimentation now being carried on with coal-fired gas turbines

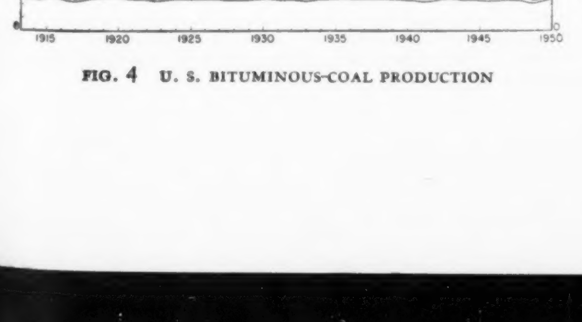


FIG. 4 U. S. BITUMINOUS-COAL PRODUCTION

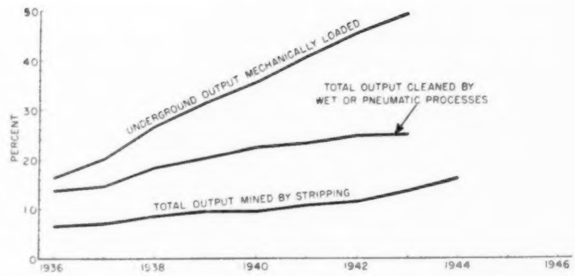


FIG. 5 MECHANIZATION OF BITUMINOUS-COAL MINING IS INCREASING

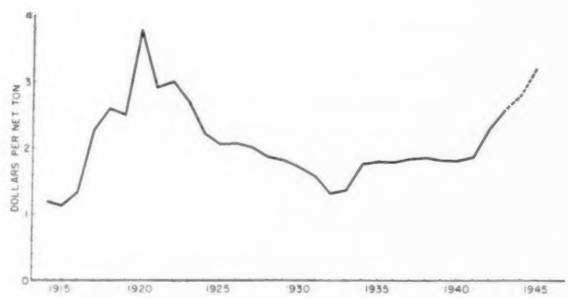


FIG. 6 BITUMINOUS COAL AND LIGNITE IN THE UNITED STATES AVERAGE DOLLARS RECEIVED BY PRODUCERS FOR COAL ON CARS AT THE MINE

by several eastern railroads promises eventually, though not in one or two years, to reduce coal consumption for operation of trains. The continuing decline in fuel consumption by electric utilities per kilowatt-hour during the past 20 years is well known and is continuing but total consumption has increased. Industrial power plants are likewise showing improvement in design and in more economical use of fuel.

What shall we expect to happen to bituminous-coal prices as demand falls 100 million tons or more below wartime levels? The answer depends upon many factors. With potential mining capacity of over 600 million tons annually and only one third of it produced west of a line through Louisville and Pittsburgh (over 90 per cent east of the Mississippi River), one would naturally expect intensive competition and the return of a buyers' market. Such a prediction has actually appeared in recent weeks in coal-trade publications. Under conditions of a free economy, it would be expected not only that a considerable drop in prices would occur, but also that many high-cost mines which would be unable to compete would close. This is a condition which the head of the United Mine Workers would not like to see, for it would mean heavy loss of membership.

With the high labor costs now prevailing and with demands for higher wage rates being voiced, producers who see in prospect a return of really competitive markets are studying what can be done to reduce costs. Mechanization in underground mines, which has contributed to the growth in production per man-day, shown in Fig. 4, has resulted in a steadily rising percentage of coal mechanically loaded in such mines for 10 years past, Fig. 5. This trend will probably continue at an even more rapid pace, for statistics indicate production per man-day is 50 to 100 per cent higher in mines equipped for mechanical loading than when loading is by hand. However, mining regions differ as to production to be expected per man-day under mechanized conditions, as well as to the gain to be realized from mechanically loading the coal produced.

Another way in which coal producers are likely to meet competitive conditions is by increasing production of strip-pit coal. Although the percentage of total tonnage that is contributed by strip mines is not large, it has been increasing gradually, as shown in Fig. 5, and from 1941 to 1944 the aggregate tonnage so produced increased about 90 per cent. Production per man-day in strip mines varies in different mining regions, as does production in mechanized underground mines, but in 1943, the average for all strip mines was 15.15 tons per day, as compared to 5.38 tons per man-day for all producing mines in the country. In one area in the far west, where stripping conditions are especially favorable, production per man-day reached 75 tons.

MECHANIZATION OF MINES AND LABOR FACTORS

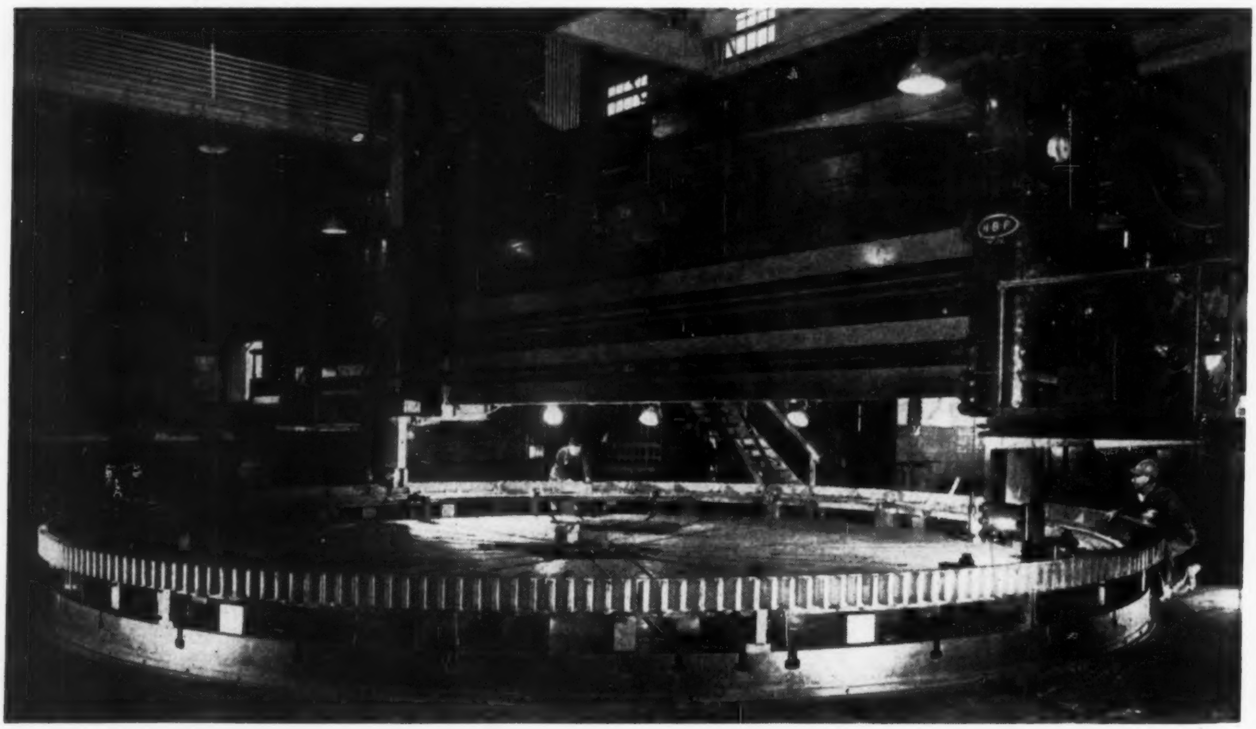
Savings in mining costs through increased mechanization and opening of new strip pits are subject to some dilution because of necessity for more thorough cleaning of the product under these mining conditions. Depletion of the older mined and higher quality coal seams means that new mines have to depend more upon cleaning plants to keep the quality of the product competitive.

It is obvious therefore that the trend of mine wages and other conditions written into contracts with mining labor are going to influence both mining operations and coal prices. If we are to see agreement on a 30-hr 5-day mining week, this may temporarily retard closing down the small or high-cost mines. The passage of another Guffey Act, and especially if it attempts not only to fix minimum prices but to control distribution by establishing different minimum prices, according to destination of shipment, may also have some effect in keeping high-cost mines in operation. Looking farther ahead, the concentration of production in larger mines operated by companies well able to obtain adequate financing seems definitely in prospect. Such mines will call for larger capital outlay but will be able to show lower production costs.

One other point should be remembered when thinking of prices of soft coal for power-plant use. Prior to N.I.R.A. days, slack or screenings almost invariably sold at prices well below the cost of production, and the producer expected the buyer of lump coal or prepared sizes to pay enough over the cost of production so as to yield an over-all profit. Today the domestic market for larger sizes of bituminous coal is being cut into by sale of coal stokers, and many moderate-size industrial plants, which formerly purchased mine-run or double-screened coals, are now bidders for screenings along with the larger power stations. All of these conditions have given slack coal a different status in the scale of coal prices.

CONCLUSION

In conclusion, it appears that for the near future prices of fuel are not likely to show much drop; they may even rise somewhat before they decline. If the strategy of organized coal-mining labor should be to call strikes intermittently on one pretext or another in order to avoid overproduction, coal-production costs will remain high, and the lowering of prices which will probably come ultimately will be postponed. If and when a drastic decline in the nation's fuel requirements occurs, this may bring about a reversal of wage trends and mining costs. That, combined with the competition which will then exist for the buyer's coal dollar, should wipe out much of the rise in fuel prices we have seen in the last few years.



TURNING ASSEMBLY FOR BRIDGE

(Interesting machining operation is this gear assembly from the Center Street Bridge, Cleveland, Ohio, built over 50 years ago, on the 40-ft boring mill in the shops of the Allis-Chalmers Manufacturing Co., Milwaukee, Wis. Due to natural wear and corrosion, it was necessary to recondition the groove in the base ring. As a consequence, new track sections had to be fitted, the castings for which are of a special composition extremely hard and difficult to machine. These track sections were faced on the bottom and then turned and bored to fit the trued-up groove in the base ring. The gear assembly is composed of 16 sections and when repairs are completed, the bridge is expected to give another 50 years of service without further attention.)

PSYCHOLOGY and AIRCRAFT DESIGN

A Study of Factors Pertaining to Safety

By PAUL M. FITTS

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ENGINEERS have usually been concerned with the design and manufacture of equipment, and psychologists with such problems as the selection and training of men to operate equipment after it is produced. However, there is a growing belief that it is often much more efficient to design machines initially in relation to human capacities and limitations than to select and train men to use machines many of which may not be adapted to human abilities.

Engineers, of course, are aware that most equipment is intended for human use, and often give serious consideration to human requirements. However, no convenient body of scientific fact is now available which can be referred to by an engineer who wants to predict how well the equipment that he is designing will be adapted to the psychological capacities and human limitations of the user. Psychologists, on the other hand, have collected a large amount of data regarding human aptitudes and capacities, but have made little effort to study the problems of equipment design, or to report psychological data so that they can be used by engineers.

About a year ago a new branch of the Aero Medical Laboratory, Engineering Division, at Wright Field, was established with the mission of conducting "psychological research to determine the capacities of individuals to operate new types of equipment, to the end that the final project will be best adapted to the man who must use it." The present paper is a report on the work of this unit and related groups in the Army Air Forces. Reference is made to the results of some of the research in this new field which brings together the sciences of engineering and psychology.

STUDY OF DIFFICULTIES EXPERIENCED BY PILOTS IN USING EXISTING EQUIPMENT

As a basis for the research program on equipment design, it seemed advisable to find out from pilots what the chief difficulties were in using existing types of equipment. Actually, it was possible to initiate research without waiting for the results of this survey, because many psychological problems in equipment design were already generally recognized. For the purposes of the present paper, however, the results of the pilot-experience study will be discussed first, and the results of several specific research projects will be reported later.

Ask a pilot to explain what some of the psychological problems are in flying an airplane and you will probably get only a perplexed stare. Ask him, however, to recount some of his most exciting experiences in flying and he will probably be able to talk for hours. For this and other reasons, it was decided to ask pilots a series of standard questions that required nothing more than an accurate description of some of their past experiences in flying. Seven standard questions were asked. Experiences in taking off, flying in instrument weather, and landing, were covered by one question each. Additional questions covered mistakes in interpreting instruments, mistakes in using controls, and descriptions of the procedure which each pilot felt required him to be "most on the ball." Finally each man was asked for any "pet peeves" about the cockpit.

Nearly all of the pilots who were interviewed were able to remember experiences relating to each question. Some experiences had involved the person being interviewed, others a close friend or buddy. In all cases only dependable information was accepted.

In order to secure an exact record for later analysis, a complete transcription of each interview was secured by means of a magnetic-wire recorder.

The collection of pilot experiences is continuing at the present time. The final categorization of different types of experiences has not been completed, and it is not yet possible to release data on the exact frequencies with which different problems occur. However, a number of accounts will be quoted which are typical of those secured. As the reader studies these accounts he will undoubtedly agree that much of the equipment used in the cockpit is greatly in need of improvement from the point of view of the user. In this first section no attempt is made to speculate as to underlying causes of human errors. Experiences are grouped, however, into a few broad categories.

Display Problems. Difficulties in reading the altimeter and air-speed indicator were described by almost half of the pilots. In spite of the fact that these instruments are used almost constantly and are among the most important of the flight group, pilots often make mistakes in reading them. Most of the other instruments in the pilot's cockpit are misread also at one time or another. The tachometer, manifold pressure, artificial horizon, gyro compass, and gas gages are among those frequently misinterpreted.

One of the most frequent difficulties is confusion in determining an indication given by more than one pointer on a single dial. Altimeters that have separate pointers to indicate hundreds, thousands, and ten thousands of feet are frequently mis read, for example. The following are instances of this sort:

"One night when I was instructing in a basic flying school, a cadet was given instructions to let down for a landing. That was the last that was heard of him that night. The next morning he called up from a point about 15 miles from the field. What had happened was that he had started to let down and had read his altimeter as 1300 feet when actually it was 300 feet. He had crashed into a forest and been knocked out for an hour or so. Afterward he had walked away and finally gotten to a telephone."

"A buddy of mine was flying at 1500 feet and looked up and there was a bunch of trees in front of him. The funny thing

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was that after it was all over and the plane had crashed, he said: 'Well, I guess I must have hit a tree.' The thing was that he had read his altimeter wrong. It was really indicating 500 feet which was just the height of the terrain at that point."

"This cadet started practicing spins at 18,000 feet. Of course spins don't break as fast at that altitude. The cadet thought the ship wasn't coming out of the spin. He had been instructed to bail out of a spinning ship if it ever got down to 3000 feet. He looked at his altimeter and it read 13,000 feet. However, he thought it read 3000 feet and bailed out. It took him a long time to get down to old mother earth. We lost one AT-6 on that deal."

The first two of these experiences are cases of misreading the position of the thousands hand on the altimeter, and the last is a case of misreading the ten-thousands hand.

Another frequent difficulty experienced by pilots is reading an instrument having a pointer which moves around the dial and also a set of numerals which can be seen through a window in the dial. Several aircraft instruments employ such an indicator in order to provide a more sensitive scale. The following account is an example of this type of pilot difficulty:

"On the P-47 series airplane there was a tachometer with a hand and also a small window showing the numbers one, two, or three. It was confusing to read because the window would register halfway between two numbers and you didn't know where you were. A particular pilot that I knew had just pulled out of a dive. He glanced at his instrument panel and thought he was indicating 2700 rpm. He happened to glance down again and saw he was registering 3700 rpm, which was way too high. Before he caught it, though, he had torn the inside of the prop right out."

Another factor frequently associated with pilot error is the use of an instrument dial which does not have uniform scale divisions. Such a variation in number of scale divisions apparently results in slower reading and more frequent errors on the part of the pilot. The following are examples of difficulties of this kind:

"Some airspeed indicators are rather hard to read, particularly when you are landing. Some are calibrated one way up to 140 miles an hour, and beyond that are calibrated on a different scale. You ordinarily fly in the upper scale, but you land in the lower one. When I fly that type airplane I generally make sure that I realize which type airspeed indicator I am using so that I will know what my speed is on landing."

"The airspeed indicator in our B-24 was numbered in ten miles an hour below the first hundred miles or so, and above that it was marked off in thirty miles an hour. This makes it quite difficult to read, especially when you just glance at it. While coming in for a final approach once, I glanced at my airspeed indicator and misread the instrument. I was supposed to have a hundred and twenty-five miles an hour, and my airspeed got down pretty low. Luckily we caught it before anything really serious happened."

There are frequent instances in which one instrument is mistaken for another. The following are examples of this difficulty:

"One night when I was co-pilot on a C-47 the pilot asked me how much fuel we had. I said, half a tank on the one we were running off of. Thirty minutes later he asked me again and it still read half a tank. I first thought that something was wrong with the gage. However, I discovered that I had been looking at the carburetor air temperature, which was directly below the gas gage. The needle on the temperature gage was pointing straight up and down and at night I had mistaken it for the gas gage above it. It was stupidity on my part."

"I can think of a near accident where a pilot just checking out in a P-51 mistook the tachometer for the manifold pressure gage. He let it climb up to 30, or 3000 rpm, thinking it was 30 inches of mercury, and continued to open his throttle until he was in war emergency. He was in a war-weary aircraft and it could have been very serious."

In addition to difficulties in reading instruments accurately, instances are reported of pilots who misinterpret or incorrectly sense the meaning of an indication. This is especially true of flight instruments, such as the artificial horizon and the cross pointers, which indicate relative position or attitude rather than a numerical relationship. The following example is a case in point:

"The error I make most is misreading the artificial horizon. I read it backward. When the wing is down I think the airplane is turning the other way a lot of times. I don't make that mistake so much anymore but I had a lot of trouble with it when I first started flying on instruments."

Probably one of the most important areas for psychological research on equipment problems is in connection with the design of new types of indicators or simplified methods for presenting present information. However, such problems were seldom mentioned by the pilots interviewed in this study, since these men were thinking about existing equipment. Much will be gained if new instrument displays can be designed so that the "natural" sensing is the correct one.

Control Problems. The counterpart of errors in the interpretation of instrument displays are errors in the operation of controls. A pilot may know what he wants to do and yet make the wrong reaction. Or he may find that the location or mode of action of a control is a source of difficulty. Many of the experiences recounted by pilots involve difficulties in control operation during emergencies. Other experiences involve incidents that happened to men with only a small amount of flying experience, or with only a small amount of time in the airplane they were flying at the time. However, all pilots can recall such difficulties, and even the best pilots admit some mistakes of this nature. The frequency of these difficulties can be reduced by redesign of control systems.

By far the most frequently mentioned error in using airplane controls was the operation of the wrong control. The following are examples of such errors:

"Taking off in a B-17, I was managing the airplane entirely by myself because I had an inexperienced co-pilot along. Without taking my eyes from ahead of me, I reached over to pull off the turbosuperchargers and in doing so I went by the supercharger controls and pulled off the mixture controls by mistake. I realized almost immediately what I had done and put them back in auto-rich again. I usually glance in the direction in which my hand is going, but that's a common mistake which I have heard of quite a number of times."

"I was up in a BT-13 in basic flying school. I started to enter the traffic pattern. When you do that you pull your prop pitch back. The prop pitch and the mixture controls both have round knobs that are set within two inches of each other. I was watching the other ships as there was a great amount of traffic, and I pulled the mixture knob back instead of the prop pitch, which would have been a serious mistake if the instructor hadn't caught it quickly."

"I was flying with a buddy in a B-26 and we were demonstrating the fact that a B-26 could fly as well on one engine as any other airplane. He feathered one engine and started to shut off his ignition switch and got hold of the wrong switch and shut off the good engine. That's a serious error when you have only two engines, but after he realized the engine was off, he turned it back on again and it came back to life."

"I have had most of my time in C-47's where the throttles are in the middle of the quadrant with the prop pitch on the left side and the mixture controls on the right side. Overseas I got

quite a bit of time on B-25's where the controls on the throttle quadrant are located with the throttles first, then prop pitch, then mixture controls. In other words, the prop pitch and throttles are opposite to those on the C-47. First time I took off in a B-25, I just naturally grabbed at the prop pitch and pulled them back. I couldn't figure out why they should be full forward in the first place. Even now once in a while when I come in for a landing I grab the prop pitch and start pulling back for throttles."

One frequently mentioned error is confusion between flap controls and landing-gear controls. Almost every pilot can recall at least one accident due to this error. Although letting up the wheels instead of the flaps is seldom fatal to the pilot, it is one of the most frequent causes of aircraft damage. Another frequent and considerably more serious error is operation of the wrong feathering button. The following are examples of this error:

"We wered own on the deck in a B-17 about halfway between Iceland and England, carrying a full load, when the number four prop ran away. My co-pilot was dozing, due to the monotony. I wasn't too sharp myself. I should have known better, since I had made the same mistake before, but I just hit the number three feathering button instead of number four. I knew right away something was wrong, but it could have been very disastrous."

"It's a common occurrence in the B-17 type aircraft with one engine giving trouble on one side to feather the other engine on the same side. I know of two or three instances where that happened. Once at Boise, number-three engine was on fire and from what they were able to determine afterward the co-pilot feathered number four and the plane spun in on the final approach. It killed several people and destroyed quite a few planes."

"I hit the wrong feathering button myself once coming off a mission. Leaving the coast of France, a burst of flack knocked out number four engine and I reached over and, instead of feathering number four, I knocked out number three. My co-pilot realized my mistake and pushed number three back on again."

Difficulty in operating the trim tabs in an emergency is sometimes reported. Usually in such cases the trim has been set incorrectly and difficulty is experienced in making a correction quickly. The following is an example:

"This incident involved a B-29 flight out of India at night. We were to take off around two o'clock in the morning. My ship was out of commission and I was to fly another airplane. I wasn't familiar with the exact flight characteristics of this aircraft, so I went down in the afternoon before flight and sat in the cockpit and checked everything. I noticed that the trim was set two degrees nose high and I assumed the pilot who had flown it last had set it that way in landing. Going down the runway that night with 135,000 pounds, I gained airspeed around 120. I tried to boost the nose off the runway but she wouldn't give. So I reached down and pulled back on the trim tab. By that time I had picked up 130 and was running out of runway, so I took my left hand off the throttle and put it on the wheel and jerked her up by force. A few more seconds and I'd have been stacked up in a bunch of trees. After the mission we checked and found that the trim tab had slipped about four degrees. Situated, as it is, downward and to the left of the pilot, it takes a good deal of time to reach down there and turn it, and I'd say it takes about a revolution to put in a degree of trim."

There is general agreement among pilots that it is a good rule in present aircraft to look first before operating a control, but that it would be desirable if this looking could be eliminated. The following comments illustrate this point:

"One day on a P-51 mission over Germany, they shot up some flack at us, and in breaking away I ran out of gas on one of my drop tanks. In changing over to an internal tank, I stuck my head way down into the cockpit and at the same time leveled out of my turn. Unconsciously, I must have pulled back on the stick, for the next thing I looked out of the cockpit and I had come up right beside another 51 and was just inches from hitting him. I just had my head in the cockpit and wasn't watching what I was doing."

"Take engine failure on a P-38, on take-off. You first have to check your airspeed to see whether you have sufficient speed to go around. You have to know where all your instruments are, where the feathering switches are, and all the other controls. You have to keep looking where you are going, because usually there is critical terrain at the end of the runway and you don't have to drop a wing much to go on in. Every pilot knows the single engine procedure, but your controls should be situated so you can feather your prop blindfolded."

REVIEW OF SELECTED RESEARCH STUDIES

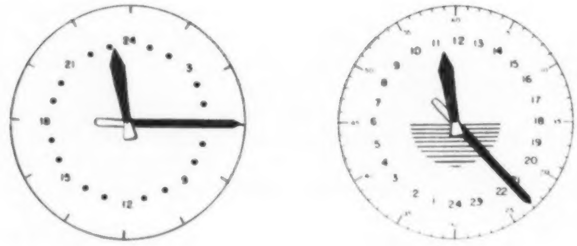
Let me turn now from a discussion of the types of errors made by pilots in using instruments and controls, and point out how a program of research on psychological requirements in equipment design can result in a reduction in the frequency of such errors.

First, however, I should like to make one point clear. I do not believe that it will ever be possible to eliminate all human errors in the use of equipment, especially of equipment as complicated as an airplane. Nor do I believe that there is any single short-cut to the reduction of pilot error. Progress must come gradually through better selection of pilots, through better training and maintenance of training, and through better design of equipment. The evidence, however, indicates that substantial improvement can be achieved by designing equipment in relation to human capacities and characteristics.

As examples of the application of scientific research methods to human problems in equipment design, ten studies have been selected for review, five on display problems and five on control problems. Space will permit only a brief comment on each of these studies. Complete reports can be secured from the Aero Medical Laboratory by those who are interested in a fuller account.

Some of the research projects which will be discussed deal with specific practical problems, and others with broad general questions of human perceptual or motor abilities. Both kinds of research projects are needed.

Research on Display Problems. The first study that I should like to report concerned the design of clock dials for reading in the military (2400-hr) time system. The research was carried out by Dr. W. F. Grether at the Aero Medical Laboratory. It might be thought that everyone would be able to read time accurately. However, such is not the case, especially when using the 2400-hr system. If a conventional clock dial is used for 2400-hr time, then 1200 must be added to all PM readings. However, if a 24-hr dial is used, then all of the numerals except one must be in unfamiliar places. Both conditions lead to errors in reading time. In the present study, eleven experimental dials were tried out on a group of A.A.F. pilots and on a group of high-school boys. In Fig. 1 are shown two of these dials. Consideration of all the data collected during the study leads to the conclusion that dial *B* was the best of the eleven dials. It has 1200 hr at the top and 2400 hr at the bottom. The lower half of the dial is shaded to suggest daytime when the hour hand is in the upper portion and nightime when it is in the shaded portion. The scale for the minute hand is the conventional one with 60 min at the top. On this dial pilots made 3.6 per cent errors and high-school students made 4.9 per cent.

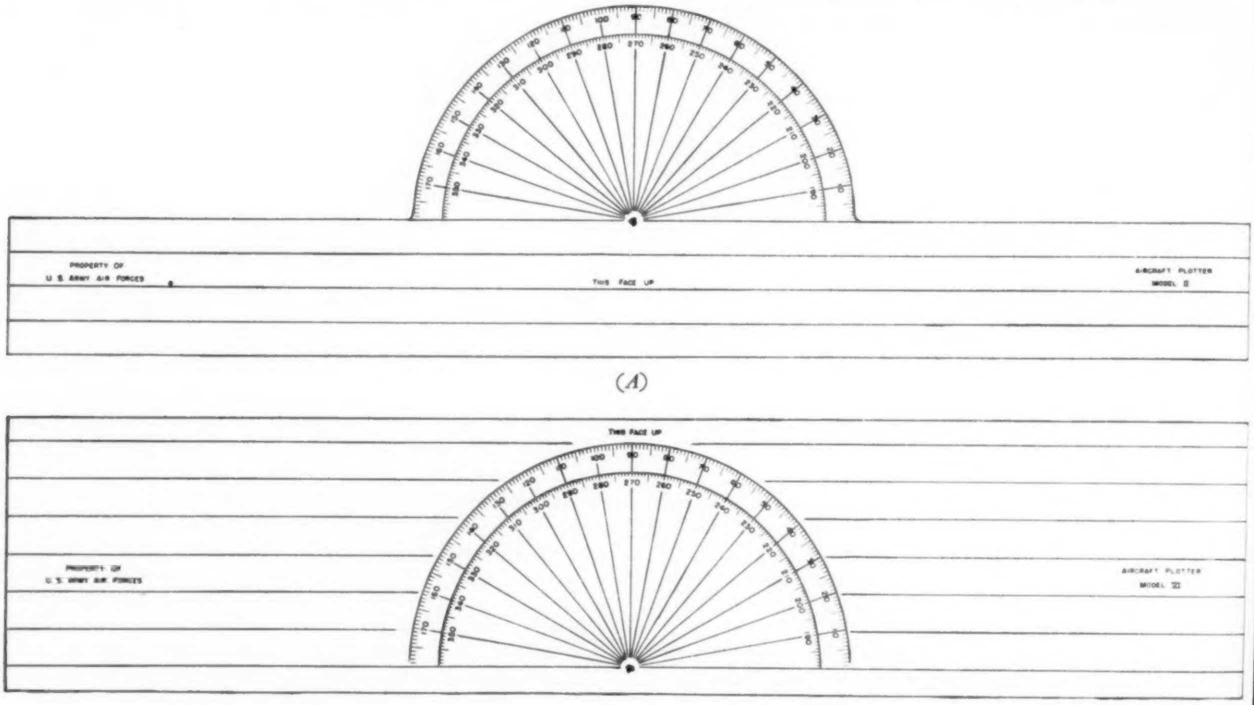


(*A*) (*B*)

FIG. 1 TWO EXPERIMENTAL CLOCK DIALS INCLUDED IN STUDY OF DESIGNS FOR INDICATING MILITARY (24-hr) TIME

were exposed for intervals of 1.5 and 0.75 sec. It was found that the dial with the fewer intermediate markings was read with significantly fewer errors during this brief exposure period. This study was carried out by Dr. R. B. Loucks at the A.A.F. School of Aviation Medicine.

Study 4 involved a comparison of four different types of artificial-horizon indicators. Subjects used in this study were aviation cadets who had received no instrument training. A standard Link trainer was modified by the addition of scoring clocks that recorded the time during which the cadet succeeded in keeping the trainer within specified minimum degrees of bank as he attempted to fly level in rough air. The amount of time that one wing was down and the stick was not in a position



(*A*)

(*B*)

FIG. 2 SINGLE-EDGE AND DOUBLE-EDGE PLOTTER USED IN STUDY OF DESIGN FACTORS INFLUENCING ACCURACY IN USING AIR NAVIGATION PLOTTERS

As high as 30 per cent errors were made on dial *A*, one of the worst of the eleven dials.

Study 2 was conducted to determine design characteristics that would reduce errors in the use of air-navigation plotters. One aspect of this study involved comparison of a single-edged protractor with a double-edged protractor. The two plotters are shown in Fig. 2 (*A* and *B*). The single-edge plotter is now used almost universally. The results showed conclusively, however, that fewer errors in plotting and in measuring courses are made with the double-edge plotter. In this study high-school mathematics students were used as subjects, since all A.A.F. navigators have been trained to use a single-edge plotter. The investigation was carried out by J. M. Christensen at the Aero Medical Laboratory.

Study 3 was part of a comprehensive investigation of factors affecting the legibility of aircraft-instrument dials. One aspect of this investigation involved comparison of the legibility of a tachometer dial with intermediate markings to indicate each 20 rpm, and a dial with markings at each 100 rpm only. The two dials are shown in Fig. 3. Aviation cadet subjects were required to read to the nearest 20 rpm on both dials. Dials

FIG. 3 TWO OF INSTRUMENT DIAL DESIGNS USED IN STUDY OF OPTIMUM SCALE MARKINGS FOR AIRCRAFT INSTRUMENTS

to bring the wing up also was recorded. As shown in Fig. 4, the cockpit of the Link trainer was modified so that one of the two flight instruments being compared could be exposed at a time.

The results of this study showed conclusively that for naive subjects, the moving element of an indicator, in this case the horizon bar, is the element that is reacted to most accurately

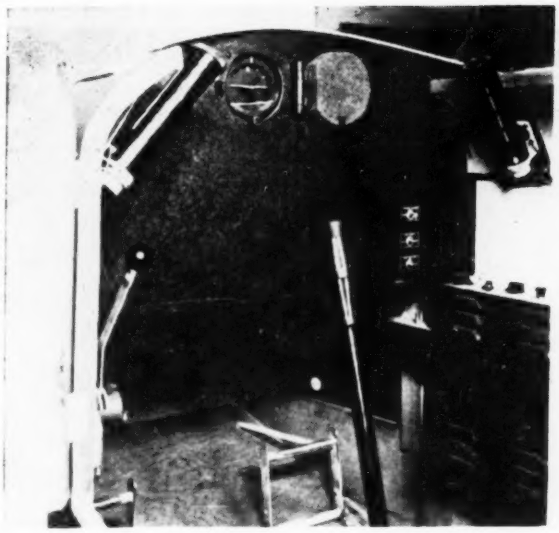


FIG. 4 INTERIOR VIEW OF MODIFIED LINK INSTRUMENT GROUND TRAINER EMPLOYED IN COMPARISON OF DIFFERENT ATTITUDE INSTRUMENTS

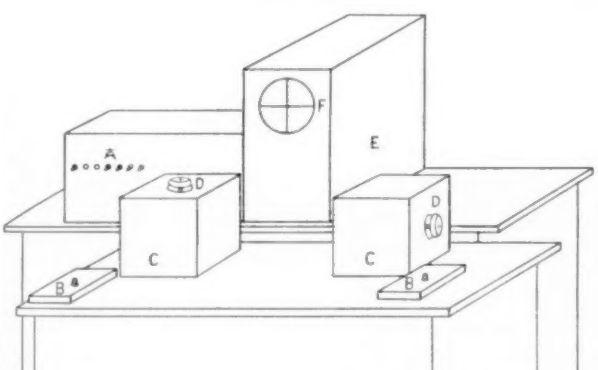


FIG. 5 APPARATUS EMPLOYED IN STUDY OF OPTIMAL CONTROL INDICATOR MOVEMENT RELATIONSHIPS

(*A*, Plane of movement switches; *B*, problem switches; *C*, control boxes; *D*, control knobs; *E*, cathode-ray oscilloscope; *F*, scope face with spot.)

Inexperienced subjects did best with an artificial horizon which had been modified to move exactly the opposite of the conventional instrument; that is, one in which the moving element rotated clockwise when the airplane rolled to the right. This study also was made by Dr. Loucks at the A.A.F. School of Aviation Medicine.

Study 5 was part of a general investigation of the most natural relationships between the movement of controls and indicators. The problem studied was that of centering a spot on a cathode tube by means of two rotary controls. The apparatus, shown in Fig. 5, permitted the experimenter to establish the control of right-left or of up-down movement of the spot by either one of the two rotary controls, and also permitted him to reverse the relationship between the direction of motion of the control and of the spot. This study is still under way and various factors are being studied systematically, such as substitution of levers for rotary controls and variation in the positions of the controls. It has been found that with the particular arrangement shown, horizontal movement of the spot is controlled most accurately by the left-hand control that is mounted on a vertical shaft, and vertical movement of the spot by the right-hand control that is mounted on a horizontal shaft. Also it has been found that subjects are much more accurate when the side of the knob nearest the display is moved in the same direction in which it is desired for the display to move, in other words, when the left-hand control, shown in Fig. 4, is moved clockwise to produce a horizontal movement of the spot to the right. This study was carried out by Dr. L. F. Carter and Capt. N. L. Murray at the Aero Medical Laboratory.

Research on Control Problems. Study 6 was part of a comprehensive investigation of human motor abilities related to control design. It involved a study of the relative accuracy of the hands and of the feet in carrying out the same control task, and a comparison of the precision of lateral and of fore-and-aft movements of a wheel and a stick-type control for the same task. The apparatus used in the study is shown in Fig. 6. The problem given the subject was to keep the pointer of an aircraft-type dial stationary. The pointer was made to wander in an erratic fashion and the subject was required to keep it centered by movement of one of the conventional flight controls. It was found that use of the rudders by the feet was less accurate than use of the stick or wheel by the hands. No difference was found between the stick and the wheel for aileron or elevator movements, but it was discovered that most pilots could make fore-and-aft or elevator control movements more accurately than lateral or aileron control movements. This study was carried out by Dr. W. F. Grether at the Aero Medical Laboratory.

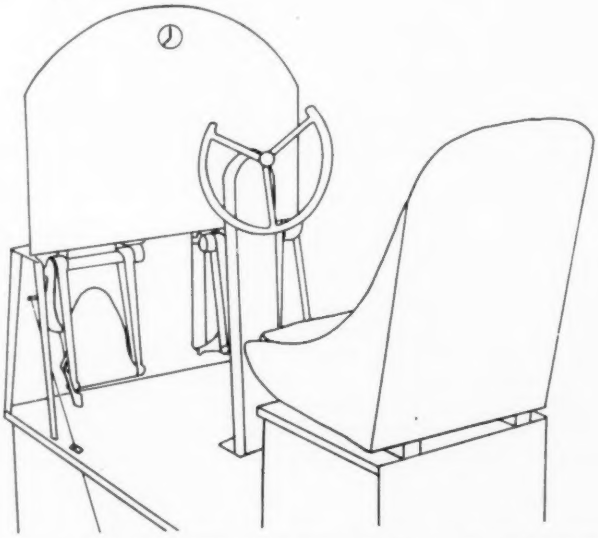


FIG. 6 APPARATUS EMPLOYED IN STUDY OF RELATIVE ACCURACY OF DIFFERENT CONTROL MOVEMENTS

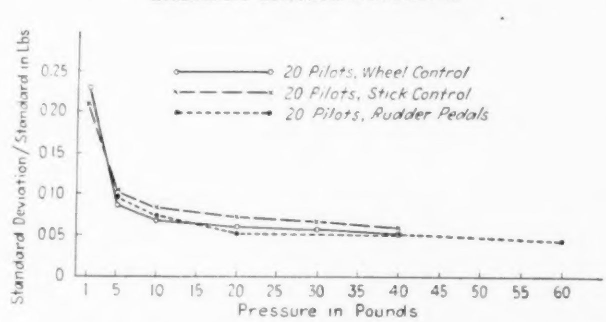


FIG. 7 CURVES INDICATING RELATIVE CONSISTENCY OF PILOTS IN APPLYING DIFFERENT LEVELS OF PRESSURE TO CONVENTIONAL FLIGHT CONTROLS

Study 7 was a basic study of the accuracy and consistency with which pilots can apply specified pressures to stick, wheel, and rudder controls. The results are shown graphically in Fig 7. The curves represent the relative variability of pilots in applying pressures to stick, wheel, and rudder pedals at selected values ranging from 1 to 60 lb. The relative variability measure is the standard deviation of the series of trials at any one level of pressure, divided by the mean of these trials. It will be seen that pilots are considerably more variable (i.e., less consistent) at low pressures than at pressures above 10 or 20 lb. If a pilot attempts to apply 1 lb of pressure, he is likely to be in error by about 20 per cent, whereas if he attempts to apply 20 lb he is likely to be in error by only 7 per cent. The shape of this curve for the higher values follows Weber's law, first formulated about a hundred years ago, which states that the intensity of a stimulus must be increased by a constant ratio of itself in order to be perceived as different. The findings of the present study are believed to be of significance for the design of controls, and suggest one reason for reports of difficulties in operating controls when very slight variations in pressure are required. This investigation was carried out by Dr. W. O. Jenkins at the Aero Medical Laboratory.

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FIG. 9 CHART SHOWING FREQUENCY OF CONFUSIONS BETWEEN EACH PAIR OF TWENTY-TWO DIFFERENTLY SHAPED CONTROL KNOBS

(The number in each cell indicates the frequency of confusions when, after a shape in the vertical column had been felt first, a shape in the horizontal row was mistakenly identified as being identical.)

Study 8 involved determination of the accuracy with which pilots can reach to different positions in the cockpit without watching the movement of their hands. Certain of the results are shown graphically in Fig. 8. The large circles represent different cockpit areas. The two circles directly below the number 4 represent the area directly in front of the seated individual. Vertical rows 3 and 5 represent the areas 45 deg to either side; rows 2 and 4 the areas 90 deg to either side, and rows 1 and 7 the areas 135 deg to either side. The top horizontal row of circles represents areas 45 deg above the level of the shoulders, the center row areas level with the shoulders, and the bottom row areas 45 deg downward from the shoulders. The diameter of each large circle represents the average accuracy with which pilots can reach to controls in each of these areas. The small circles represent greater accuracy. The numerical value in inches is given below each circle. All tests were made at distances of 30 in. from

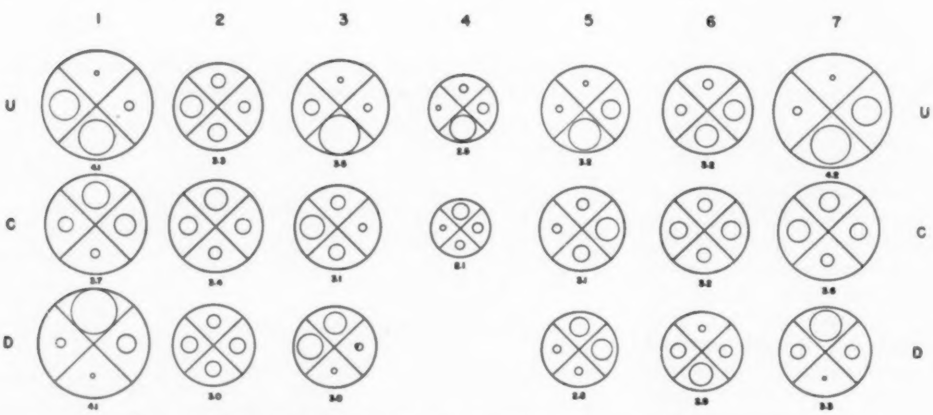


FIG. 8 RELATIVE ACCURACY OF PILOTS IN REACHING TO DIFFERENT COCKPIT AREAS

(The size of each large circle is proportional to the accuracy score for that area, with a small circle representing greater accuracy. The relative size of the four circles within each large one is proportional to the number of errors in each quadrant.)

the mid-point of the shoulders and with subjects wearing black-out goggles which permitted them to see two visual reference lights but not to see where they were reaching. Findings on accuracy can be summarized as follows: Controls directly in front are reached for most accurately. As regards areas other than those directly ahead, controls farther to the rear than 90 deg and controls placed above the level of the shoulders are reached for least accurately. In addition to these findings consistent error patterns were discovered. These patterns are represented by the four small circles within each large circle, which indicate the proportion of errors in each direction from the position desired. It will be noted that when pilots reach upward, they tend not to reach high enough, and when they reach downward they usually do not reach far enough down. The application of these findings to the arrangement of machine controls is being studied at the present time. This study was conducted by the author.

Study 9 was undertaken in order to provide a set of differently shaped control knobs that could be recognized easily by touch alone. Several studies have been made using many different shapes, mounted in different ways. Fig. 9 shows the results of one study in which 40 pilots tried to identify each of 22 knobs mounted on a vertical panel. Part of the tests were conducted while subjects wore flying gloves. All subjects wore black-out goggles. In the illustration is shown the number of times each knob was confused with every other one. It will be seen that the first eight shapes were never confused among themselves. Other pairs of knobs were confused very frequently. For example, a cross was confused 42 times with a six-sided knob. The eight best shapes are shown in Fig. 10. These shapes are suitable for use where it is desired to code a control for certain recognition by touch. This study was carried out by Dr. W. O. Jenkins at the Aero Medical Laboratory.

Study 10 does not involve equipment used by the pilot, but is reported because it furnishes a striking example of the amount of improvement in effectiveness that can be achieved from the redesign of controls. The study involved a comparison of the accuracy of tracking and framing a moving target with two types of hand-grip controls. The apparatus used in the study is shown in Fig. 11. It provided a target that moved in a simulated pursuit curve across a hemispherical-shaped screen, and a series of clock scores of the time during which azimuth and elevation tracking and ranging were within specified angu-

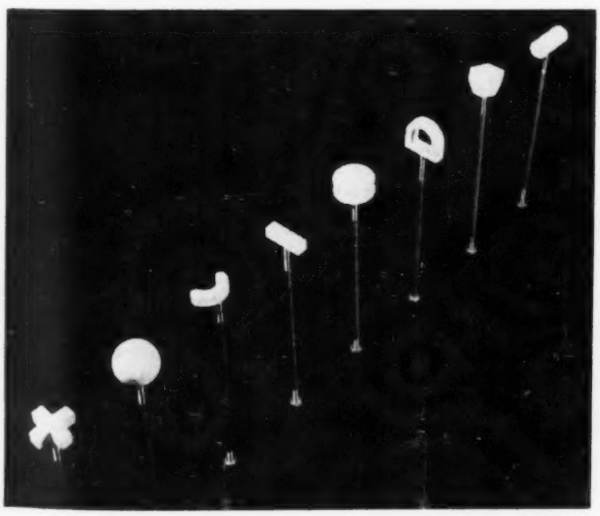
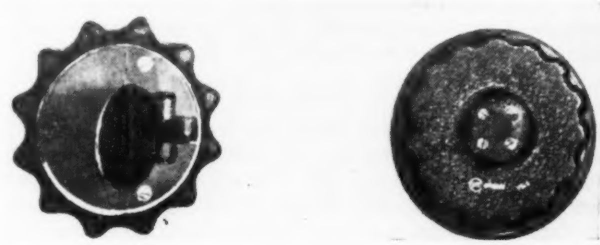


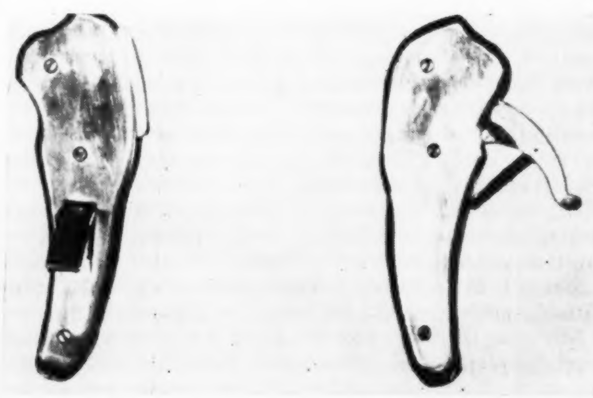
FIG. 10 EIGHT SHAPES AMONG WHICH THERE WAS NO CONFUSION WHEN PILOTS IDENTIFIED DIFFERENT SHAPES BY TOUCH ALONE

FIG. 11 SUBJECT OPERATING S.A.M. PEDESTAL SIGHT MANIPULATION TEST



Left handgrip Right handgrip

A



Left handgrip Right handgrip

B

FIG. 12 GUN-SIGHT HANDGRIPS NOW IN USE (*A*) AND EXPERIMENTAL TYPE HANDGRIPS (*B*)

lar tolerance limits, and when combinations of these components and triggering were accomplished successfully simultaneously. The controls that were compared are shown in Fig. 12. Without taking time to present the rationale of the design of these controls, the results can be summarized as indicating approximately 25 per cent more time on the target with the new-type control *B* than with control *A*. Control *A* is actually used with the sight at present. The members of this Society will be

(*Continued on page 163*)

The AMERICAN STAKE *in* WORLD ENGINEERING

By FENTON B. TURCK[1]

ENGINEERS throughout the world share the impulse to continually explore ways of helping each other contribute to the progress of mankind. This is a common objective of engineers in all countries. Today this creative spirit of engineers is called upon to help rebuild a war-torn world and fortify the economic stability of nations.

The formation of the World Engineering Conference as a continuing international organization of engineers opens up a whole new field of effort and accomplishment to the engineering profession in the United States. As participants, either direct or indirect, in the Conference, American engineers now have a responsibility to their professional colleagues in other nations which compares in many respects to the responsibility assumed by their government in the United Nations. It is important for them to understand the magnitude of their stake in this new evidence of world co-operation as well as the particular contribution which they may make.

WORLD ENGINEERING CONFERENCE FORMED IN 1946

The World Engineering Conference was set up at the recent International Technical Congress which met in Paris Sept. 16-19, 1946. W.E.C. was a direct result of discussions at the Paris meeting among 1200 engineers from 30 countries. Almost without exception, these men realized that the generally shattered and confused state of the world economy placed upon them and upon their profession a particularly large responsibility, and that order cannot possibly be created out of the current economic chaos without guidance from and hard work by engineers. With an enormous problem to be faced, there was a strong desire for an international agency to gather information and opinion from the profession. Accordingly, after four days of deliberation and argument, a draft constitution was signed on Friday, Sept. 20, 1946, and a loose international federation of world engineers came into being. As an industrial organization of engineers, concerned with the problems of the world engineering profession, the W.E.C. does not compete with nor supersede existing international bodies concerned with specific techniques, but rather does it aim to encourage further international contact between the specialists of the world.

Now that the Conference is a going proposition, it must be supported strongly by engineers in the richest and best-equipped nation on earth. Everywhere abroad there is nothing but amazement and admiration expressed for the engineering and industrial achievements of the United States during the recent war. Engineers in physically ruined and financially destitute countries everywhere are looking to America, and particularly to their professional counterparts in America, for advice and help in rebuilding their devastated homelands. In reply, American engineers can give Europe and other devastated areas not only valuable instruction in war-developed engineering technique but also—and almost as important—a professional confidence that engineering can be expected to perform successfully even greater tasks in the future than it has in the past. This confidence must be imparted in some degree to foreign engineers before they ever can be expected to shoulder their heavy burden of reconstruction with hope and courage.

In the spirit of pure humanity, therefore, it is incumbent upon American engineers to co-operate with their colleagues. But even those engineers who are completely uninterested in helping other nations to work free from their troubles should feel impelled to do so now out of simple self-interest. The fact is that American engineering men can learn a great deal from Europe. Admittedly, engineering has never had the full scope of application in Europe that it has gained in this country, but Europe has made many vital contributions to engineering developments which Americans are prone to regard as strictly their own—the automobile, for instance. We can always use more.

In addition, American engineering has had very little contact with the outside world since 1939. Although we in this country used that time of war-induced isolation to develop and perfect and produce a staggering number of new things—from the atomic bomb on down—many other new devices and techniques were invented abroad, as anyone knows who has read the story of foreign wartime engineering. The point is that by importing foreign ideas, American engineering can improve itself and free itself of the danger of stagnation. Too many European techniques are in constant usage in this country for anyone to doubt that, in order to prosper, American engineering must be fed from without as well as from within. By coupling importation of foreign accomplishments with liberal exporting of our own ideas and techniques, the engineering profession throughout the world cannot help but benefit. And the benefaction will not be confined to areas outside the United States.

Since both plain humanity and self-interest point toward world co-operation among engineers, with American engineers as important participants, it is time to consider the only international body which, at the present time, represents such co-operation—the World Engineering Conference. It should not be thought, however, that W.E.C. came into being suddenly. It is, to be sure, the first flowering of a desire for international organization of engineers, but the desire itself is 25 years old and has been growing steadily.

HISTORY PRECEDING W.E.C.

It was the instruments of death developed for World War I, along with the carnage, wreckage, and destitution which they produced, that first gave engineers throughout the world a feeling of joint responsibility, for engineers had played a role with a prominence historically unprecedented both in making the war machines and in picking up the pieces afterward. It was felt at the time, as it is felt even more strongly today, that a united world body from the profession could, by exchange of ideas, raise its own level and help raise the world standard of living more quickly and efficiently than before.

The first attempt to establish such an international organization was made in 1921 when Herbert Hoover and a delegation of American engineers visited England and France to learn the reaction of European engineers to such an idea.

[1] Member A.S.M.E., Member E.J.C. Committee on International Relations, President, Turck, Hill and Co., New York, N. Y.

Early in 1922 Dr. Calvin W. Rice, then secretary of The American Society of Mechanical Engineers, made a proposal for a world federation before American engineers at a meeting in Washington, D. C., and suggested that a special congress be convened in Prague for further consideration of the question. Warm response came from Czechoslovakian engineers, who set to work immediately on preparatory plans. In 1924, at the first Congress of Scientific Organizations in Prague, the formation of a world federation was discussed and out of this discussion came a plan which the Czechoslovakian delegation submitted formally to the World Engineering Congress at Tokyo in 1929.

The plan was studied at this meeting and certain modifications were made on the advice of American engineers. The only result, however, was the following resolution (unanimously approved at the final session on Nov. 7, 1929):

It is recommended that the delegates from the various countries study the situation and the position of engineers in their respective countries to see if it would be desirable and opportune to take action in view of the creation of a world federation of engineers, after which the question may be submitted to the next world congress of engineers.

The reason the high purpose of the immediate postwar years had dwindled down to this indefinite and procrastinating recommendation was a combination of conflicting national aims and the prospect of no imminent danger of war. In 1929 there seemed to be much less point in a world association of engineers than there had been a decade previously. But nevertheless, although the step forward was a remarkably small one, it had been made. Unfortunately, the general stagnation of engineering activity resulting from the 1930–1936 depression, together with the international uneasiness which led to World War II three years later, prevented the Tokyo delegates from pursuing the resolution's intent.

Nevertheless, in England and on the continent, the Tokyo Congress was not forgotten, even during the war years. European engineers planned so carefully that it was possible, less than 18 months after the cessation of hostilities, to hold the congress in Paris at which more than 25 years of effort reached their consummation in the formation of the World Engineering Conference.

The W.E.C. constitution was signed on Friday, Sept. 20, 1946, at 11:30 p.m. Signatories for the United States were Morris L. Cooke, consulting engineer of Philadelphia; C. E. Davies, secretary of The American Society of Mechanical Engineers and chairman of the Committee on American Participation in the International Technical Congress; and Fenton B. Turck. Other American engineers who participated in the Paris discussions were: Hugh L. Dryden, F. B. Farquharson, L. E. Grinter, William J. Hargest, Max Jakob, Everett S. Lee, Edmund R. Purves, Hunter Rouse, M. Salvadori, and Col. Theo. A. Weyher. These men were in Paris as part of the American delegation organized by the Committee on International Relations of the Engineers Joint Council. On this occasion they assumed responsibility as unofficial representatives of all American engineers. Upon invitation from the newly formed W.E.C., they also accepted responsibility for acquainting American engineers with the objectives of the Conference, for soliciting the co-operation of Latin-American engineers, and for preparing definitions of the ambiguous terms "engineer" and "technician."

The new organization assumed five specific duties: (1) To conclude the business of the 1946 International Technical Congress; (2) to prepare for the establishment of a future World Engineering Federation in which all engineering bodies may participate; (3) to assure the holding of future international engineering congresses; (4) to undertake certain pressing tasks which ultimately will be taken over by the proposed world federation; and (5) especially to establish contact with the Economic and Social Council of the United Nations (ECOSOC) and with the United Nations Educational Scientific and Cultural Organization (UNESCO).

At the time of the Paris discussions, it became apparent to many of the delegates (including those from the United States) that the time was not opportune for the formation of a complicated world federation of engineers. Too many factors lacked definition, such as the international differences between graduate engineers and technicians. Even though a great deal of work had been done by Great Britain, France, Czechoslovakia, and Switzerland on elaborate proposals for such an all-inclusive federation, it was generally agreed that the time was not ripe. All deliberations were amiable and cordial. The resulting constitution aims at the establishment of a simple, inexpensive, loose organization which will be continuing with respect to function, yet tentative with respect to structure. The form adopted for the organization therefore became a conference rather than a more binding federation.

DRAFT CONSTITUTION OF W.E.C.

According to the draft constitution, membership in the World Engineering Conference will be by national committees set up by all the engineering organizations in each participating nation. These committees will designate three delegates, each having one vote, to the Council of W.E.C. In countries where no national committee exists, W.E.C. itself will designate the delegates. The function of the Council will be to determine the general line of conduct and policy. It will meet annually.

W.E.C. will be administered by an executive board, appointed from the Council and consisting of 15 members and a chairman. No country may have more than one member on the executive board. The chairman of the Council will also serve as chairman of the board.

A. Antoine, president of the French Union of Engineers and Technicians, was elected chairman of the Council for the first year. Delegates from the following countries were elected to the executive board: China, Czechoslovakia, Egypt, France, Great Britain, India, Poland, Switzerland, and the United States. Additional delegates will be elected by the board itself.

Fenton B. Turck will represent the United States on the Council until the American national committee is organized and designates its own representatives.

The draft constitution provides the following means for financing the activities of W.E.C.: (1) Fees subscribed by member national committees; (2) funds left over from the 1946 International Technical Congress; (3) sale of publications and papers; and (4) possible subsidies from UNESCO. For the first year, minimum contribution for each nation was fixed at $250.

After considering the report of its delegates, Engineers Joint Council Committee on International Relations has recommended that constituent societies of E.J.C. support the organization of a W.E.C. national committee broadly representative of all engineering societies in the United States.

PROSPECTS AND OPPORTUNITIES

W.E.C. is a step in the right direction and a longer step than any taken in 25 years of intermittent progress. For this reason alone, W.E.C. is deserving of support and interest all along the line, both within American engineering societies and in relations between American engineers and their foreign associates. Any expression of American interest will be reciprocated twofold from abroad, where American confidence and American leadership are regarded more highly than anyone who has not

been abroad recently can believe. Increasing consolidation of engineers in the United States and increased relations between American and foreign engineering societies will be the evidence our colleagues in Europe and Asia are looking for. W.E.C. is a logical focal point for all such activity.

Another problem of prime importance with which American engineers should concern themselves is the Engineering Section of UNESCO. This body, recently established at Paris, has for its purpose the encouragement of cultural exchanges, both intellectual and technological, among all nations. Its Natural Sciences Division, of which the Engineering Section is a part, specifically concerns itself with international exchanges in pure and applied science. While in Paris, the American delegation spent a great deal of time talking to members of UNESCO's Engineering Section. They were discouraged to find the stamp of traditional European scientific thinking, with its almost exclusive concern for pure science, almost everywhere in the Natural Sciences Division. Of a staff of 30 in the Division, there were only four in the Engineering Section and only two of these were actually engineers.

With both UNESCO and W.E.C. established in Paris, there is now opportunity for engineers to work hand in hand with UNESCO, until perhaps W.E.C. itself may be absorbed into the United Nations. On that day there would be a unity of the world's engineers such as never before contemplated and engineering itself would receive all the tremendous influence accruing naturally to any organization which is a part of the first world-wide governing body. It must be emphasized again, however, that the entering wedge is through W.E.C.

But all this lies in the comparatively distant future. Earlier in this article it has been noted that humanity and self-interest make world co-operation a duty for the American engineer. It is also an opportunity for him as a good citizen of his own land.

Through the agency of W.E.C. invitations will soon be coming to our great laboratories. The American engineer will be asked abroad and welcomed there. He will go both to instruct and to be instructed, to take over the engineering technique which America must contribute to Europe, and to bring back some of the purely scientific knowledge in which Europe specializes. But he will also represent his country abroad and add to foreign understanding of Americans.

Should the American engineer heed calls from countries whose political ideals are opposed to ours or whose technical standards are lower? Should he drop important work at home to contribute to convocations which promise little personal satisfaction and less professional progress? In a certain sense, these questions epitomize the challenge to traditional American isolationism. Now that our government has given up this position, it behooves each citizen to do the same in his private life. The foregoing questions must be answered affirmatively and the affirmation should be enthusiastic and without condescension.

The World Engineering Conference therefore presents three opportunities to American engineers: (1) To dispel world fears about the failure of American leadership; (2) to guide the engineering efforts of UNESCO; (3) to show people of other countries, by example, the American kind of political and economic freedom. In essence this is the report of the Committee on American Participation to the Engineers Joint Council Committee on International Relations, made at a meeting in New York, N.Y., on Oct. 23, 1946. To these opportunities are added two things more: The engineer's duty as a humanitarian to help pick up the pieces after another great war; and the engineer's duty to improve his profession by capitalizing on the mutual professional benefit which will be a quick and rewarding result of increased relations with other engineers throughout the world.

The formation of the World Engineering Conference is evidence of the desire of engineers to perpetuate the advances of world co-operation of the engineering profession. The spirit rather than the form of organization justifies support of every engineer throughout the country. Each engineer can find a personal satisfaction in the fact that his effort to further world co-operation adds directly to the security and happiness of mankind.

Shall We Fight or Welcome Foremen's Unions?

(*Continued from page 130*)

top management will have pushed its foremen over on the other side of the fence. There is a strong question as to whether the managements which are today so bitterly fighting the unionization of their foremen have not been carried away by prejudice, personal antagonism, and a blind refusal to back down. There is a strong question whether in these bitter fights against unionizing foremen, those top managements are not completely overlooking the recommendation of Mr. Gantt "to obtain facts or lose in their competition with those who base their action on fact."

Typographical unions are among those who for many years have had the foremen in their trades as union members. In many shipyards of this country supervisors have long been members of unions. Nearly five years ago I was invited to the eighty-fifth anniversary of the San Francisco Bay area's International Union of Ship-Wrights and Joiners. In that organization which has lasted far longer than any individual shipyard on the Pacific Coast, shipyard supervisors have the most influence as officials and senior labor statesmen of the local. The Kaiser Shipyards in California, with which I was also connected for a time, had one shipfitter quarterman who was chief job steward for his department. That quarterman and chief job steward was the next highest foreman in a department having several thousand employees.

SUMMARY OF GUIDING PRINCIPLES

Let's sum it up this way:

1 There is no proof that has been demonstrated that foremen's unions in themselves will decrease the efficiency and productivity of the foremen, whether those foremen are actual members of management or only straw bosses.

2 If management takes its foremen into the management circle and has all of them participate in the observation, analysis, and solution of current operating problems, those foremen will know that they are a part of management. No one will have to keep telling them that they are. They will also gain so much satisfaction as management members from their contributions to the welfare of their corporation and from their close working relationship with top management that they will be disinclined to form or join a union.

3 It has been demonstrated that in many cases the unionized foremen have actually helped the company to overcome union resistance in meeting critical managerial situations. It has been demonstrated repeatedly in various parts of this nation and in England that if top management uses its supervisors as potent and creative members of management, those supervisors will live up to that responsibility, will increase the quantity and quality of output, and will lower the unit cost, regardless of whether they do or do not belong to a union.

POSTWAR DESIGN FOR A.S.M.E. RESEARCH

By ROBERT A. O'BRIEN

RESEARCH ENGINEER, A.S.M.E., NEW YORK, N. Y.

THE attention of industry great and small is focused today in a significant degree on research. In the first place, the vast amount of war research has to a great extent brought about a research-mindedness not heretofore existent. Secondly, the postwar period with its attendant problems has further served to emphasize the importance of research as a tool in industrial economic survival. Because of this intensified interest, The American Society of Mechanical Engineers has geared its research activities to fit the needs of the times. Its research staff has recently been enlarged to handle anticipated requirements.

THE A.S.M.E. RESEARCH FUNCTION

For twenty-five years the Society has acted successfully as a catalyst to bring to light problems common to one industry or to groups of industries and to arrange for the solution of these problems either in part or in their entirety. Furthermore, in acting as a catalyst, the Society can continue to be particularly helpful by sponsoring investigations along broad lines for these groups, which may be too general or too expensive for one company or association to develop.

HOW IT OPERATES

Supervision of A.S.M.E. research—which is established by constitutional authority—resides in the Research Committee under the general direction of the Board on Technology. Current membership on this committee is as follows:

(1) Herman Weisberg, chairman, mechanical engineer, electrical engineering department, Public Service Electric and Gas Company, Newark, N. J.

(2) George A. Hawkins, professor of thermodynamics, School of Mechanical and Aeronautical Engineering, Purdue University, Lafayette, Ind.

(3) Ernest L. Robinson, structural engineer, turbine-generator engineering division, General Electric Company, Schenectady, N. Y.

(4) William A. Newman, manager, department of research, Canadian Pacific Railway Company, Montreal, Canada.

(5) John P. Magos, director of research, Crane Company, Chicago, Ill.

To implement further this activity, special and joint research committees are appointed, operating under the standing committee, for the purpose of investigating or guiding the investigation of specific problems. There presently exist sixteen active groups of this nature which follow, together with the names of the chairmen thereof: Lubrication, B. L. Newkirk; Fluid Meters, S. R. Beitler; Metal Cutting Data and Bibliography, M. Martellotti; Mechanical Springs, J. R. Townsend; Effect of Temperature on the Properties of Metals, N. L. Mochel; Condenser Tubes, A. E. White; Boiler Feedwater Studies, C. H. Fellows; Elevators, D. J. Purinton; Strength of Vessels Under External Pressure, F. V. Hartman; Cutting Fluids, O. W. Boston; Critical-Pressure Steam Boilers, H. L. Solberg; Plastic Flow of Metals, A. L. Nadai; Furnace Performance Factors, A. R. Mumford; Internal-Combustion Engines, Lee Schneitter; Properties of Gases and Gas Mixtures, J. A. Goff; and Automatic Regulation Theory, C. E. Mason.

SOURCE OF FINANCIAL SUPPORT

Because the Society's policy has been to secure aid from those who benefit most from the results of specific projects, financial support for A.S.M.E. research has come primarily from industrial sources. Valuable assistance also has been given by The Engineering Foundation.

The immediate objective of The Engineering Foundation is the furtherance of researches directed toward solutions of problems of benefit to the engineering profession and the public, of technological and human interest, in which engineering methods and knowledge may be utilized.[1] Some researches would not have been initiated and many would not have been followed to completion without the Foundation grants in aid. In many cases, the early interest of the Foundation and the grants made were vital to the organization of the projects and in interesting industry and individuals sufficiently to lead to subscriptions for their support. It is worthy of note that The Engineering Foundation grants to A.S.M.E.-sponsored research have amounted to approximately $106,000 since 1922.

Without splendid support from industry, many of the most outstanding A.S.M.E. research projects would never have been realized. The amount contributed by a broad cross section of industry and by many individuals has mounted to a significant total of $586,000 over the same period of years. A sum of this magnitude must reflect the faith which contributors have had in the Society, its Research Committee, and the various joint and special research committees. In reality, the term "contributors" is not at all correct. Rather, such financial support must be regarded as coming from "investors" who, experience has shown, have invariably realized a fair return on the monies invested.

The A.S.M.E. has made an investment in its research program. Although since 1922 only about $10,700 has been appropriated for actual cash support of specific projects, the inclusion of staff salaries and office expense in research matters has raised that figure to $130,000. Its membership has further enhanced that total by countless hours given without cost when acting as committee members.

THE PAST RECORD

Returns from this combined investment are shown by the following brief summaries of typical investigations which have been accomplished under the guidance of the special or joint research committees noted:

(*a*) *Joint Research Committee on Boiler Feedwater Studies.* Appointed March, 1925. Composed of representatives of the A.B.M.A., A.R.E.A., A.S.M.E., A.S.T.M., A.W.W.A., and E.E.I. It would be difficult to do more than guess the ultimate

[1] The Engineering Foundation Reports Twenty-Five Years of Service—1939.

value of the researches undertaken by this committee—not only in direct research costs, but in stimulating thinking on the general subject of the technical significance of water as a raw material in the generation of steam. As the result of the impetus given by this joint research committee to scientific effort on the part of many research workers throughout the country to these problems, steam is now being generated at more economical high temperatures and pressures with a rather clear understanding of the reactions of steam and water and the metal with which it is in contact. Reactions between the various chemical identities in water used in the generation of steam which create problems both of scale formation and corrosion have become better understood, and their prevention or control have been materially advanced. Methods of water analysis have been developed which are more applicable to boiler water and feedwater than methods previously standardized by the joint committee of the A.W.W.A. and A.C.S. The investigation of caustic embrittlement has clarified to a great extent the mechanics of its development and methods of prevention or control. About $81,250 has been subscribed to support these developments and more than 100 papers have been published under the sponsorship of this committee.

This committee, which by common consent was relatively inactive during the war years, is now planning an aggressive future, and it is expected that an outline of its activities will be available by June, 1947.

(*b*) *Special Research Committee on Furnace Performance Factors.* Appointed October, 1941, for the purpose of collecting and rationalizing data on the several factors which influence the performance of commercially important furnaces, as an aid to design and operation. About $15,000 has been subscribed thus far by prominent operating utilities, boiler manufacturers, industrials, and The Engineering Foundation. Among the factors to be, or which have been, studied are additional work on physical and chemical properties of furnace ash and slags, furnace action on exposed structural material, furnace geometry, progress of combustion in the furnace cavity, amount and distribution of radiant-heat absorption including the influence of slag deposits, etc. Thus far, fourteen reports have been published under the auspices of this committee. Statistical data have been collected from operating companies and have been partially analyzed. A field investigation has been under way on a new high-pressure installation during which the effect of flame direction, rating, and excess of air on the transmission of heat into the walls of the furnace has been studied. Full analysis of resulting data is not yet available.

(*c*) *Joint Research Committee on the Effect of Temperature on the Properties of Metals* (A.S.T.M.-A.S.M.E.). Appointed December, 1924, to encourage investigations of metal properties at high temperatures. The rapid rise in steam pressures and temperatures which has characterized the development of the steam-generating station, together with the increasingly high temperatures at which oil refining and other processes have been carried on, created a demand for materials which would resist such environment. About $64,000 has been subscribed to the work of this committee in determining high-temperature physical properties, and the resulting data have been translated to a great extent into commercially available materials suitable for contemporary operating requirements. Currently, investigation of materials appropriate for gas-turbine applications is under way.

In recent years, considerable attention has been given to the phenomenon of graphitization in steel for the reason that the time-temperature relationship in the modern power plant reached the point where the planned state of carbon in the steels employed in certain applications was broken down, giving birth to the weak and even dangerous graphite form. This committee is investigating that portion of the problem dealing with carbide stability in carbon- and alloy-steel castings at high temperatures and over long periods of time.

THE PRESENT AND FUTURE

Fifteen investigations under A.S.M.E. sponsorship are currently under way in private, government, or university laboratories. Four additional projects are almost ready to enter the solicitation stage for financial support.

Unfortunately, expansion of A.S.M.E. research activities, as proposed in 1940 and outlined in "A.S.M.E. Committee on Research"[2] was arrested by the recent war and the financing program and the increase in staff assistance recommended in the report was postponed until revived by Council action late in 1946. The Research Committee is now prepared to consummate this plan.

Attention is again invited to the fact that, where fundamental or background research in mechanical engineering and related subjects is required on an industry-wide basis covering several industries, or between manufacturer and user, which is adaptable to co-operative approach, the A.S.M.E. offers an ideal co-ordinating agency. Industry is invited to take advantage of this proved means of attack. A.S.M.E. professional divisions, standardization and code committees, and individual members are requested to send their research suggestions to headquarters or to bring them to the attention of members of existing research committees.

Humanizing Engineering

IN THE United States we have been concerned with the conservation of soil and forests and with the conservation of material by better engineering methods, but very little has been done about human engineering, according to an article in *The Clarkson Letter*, December, 1946. All engineering students know that much of the progress made in engineering has come through the improvement of the various materials. The makers of mechanical devices know that success often depends on the quality of materials. In the same way progress and success in life depend on getting quality in human material.

Before and even since the war, there has been a keener perception of the importance of humanizing engineering. If we think that we are approaching the problem forcefully and effectively, we have only to open our eyes and to view the present state of affairs. The war was an experience, stimulating a common aim and the spirit of fellowship, but only enough to show what tremendous advances are within our reach.

Our system of government requires good citizenship. Under absolutism, men do not need brains or character; they fall in line at the command of others.

It is admitted by many engineers and engineering students that the field of engineering is sadly lacking in so far as humanistic studies are concerned. It is admitted that engineers need a better knowledge of English, a better sociological perspective, more history, and more economics. Human psychology and business science are also great humanizing factors in engineering.

If the engineer is not read in the vast fields of philosophy and literature, is not interested in his own economic system and his own society, or cannot establish a mutual feeling of ease when meeting with other people, and cannot sustain a normally intelligent conversation with his fellows, then he feels his own inadequacy as an educated citizen. The engineer should want to humanize his engineering skill by developing at least an appreciation of the "humanities."

[2] MECHANICAL ENGINEERING, March, 1941, pp. 200–202.

A.S.M.E. COMMITTEE ORGANIZATION CHANGES

Society Committees Regrouped Under Six Boards

At the 1946 Annual Meeting of The American Society of Mechanical Engineers two important modifications were made in the committee organization of the Society.

One change consisted of:

1 The establishment of six boards to which limited authority of the Council may be delegated.

2 The regrouping of the standing and special committees which formerly reported directly to the Council under these six boards.

3 The assignment of members of the Council for service on boards and committees.

The second change consisted of a clarification in the plan adopted in 1945 by which vice-presidents would become responsible for leadership in the eight regions into which the sections of the Society are grouped.

BOARDS AND COMMITTEES

The concept of a board, differing from that of a committee, one of the novel ideas in the new arrangement, is defined in the By-Laws as a body "to which the Council at the beginning of the year may delegate, for a period of one year, its authority for specific responsibilities for the performance of any duties required to be performed by the Council subject to any limitations prescribed by the Council. One member of each Board shall be a Director at Large appointed annually. The chairman of each Board shall be entitled to a seat on the Council without vote."

Fig. 1 shows the arrangement of committees and boards as provided in the new By-Laws. The important changes from the previous arrangement are noted in what follows.

The Executive Committee, now made up of the President, two vice-presidents, and two directors at large, acts for the Council between its two meetings each year. The Treasurer, representatives of the Finance and Organization Committees, and the Secretary sit on the Executive Committee without vote.

The Organization Committee, a new committee, reviews the organization and personnel of boards, committees, and the Secretary's office and recommends policies and procedures pertaining to their effective operation.

The Board on Technology, which takes meetings, publications, professional divisions, and research under its supervision, is concerned with advancing the technical life of the Society. In addition to the standing committees shown on the chart, this Board has three special projects, the Metals Engineering Handbook Board, the Nuclear Energy Application Committee, and the newly authorized Managing Board for the *Applied Mechanics Reviews*.

The Board on Codes and Standards, organized early in 1946, secured from the Council on Dec. 2, 1946, a delegation of authority by which the Board may approve codes and standards in the name of the Council.

The Board on Membership guides the Admissions Committee and two committees, formerly special, Membership Development and Membership Review. Membership Development is concerned with increase in membership and Membership Review with special cases regarding members that require individual attention.

The Board on Education and Professional Status is concerned with engineering education, improving the development of young engineers, fostering the study of engineering history, improving the status of engineers, co-operating in improving the standard for granting the license, and maintaining a high standard of ethical practice. The Engineers Registration Committee, now under this Board, was formerly a special committee. The Education Committee is new in the sense that its

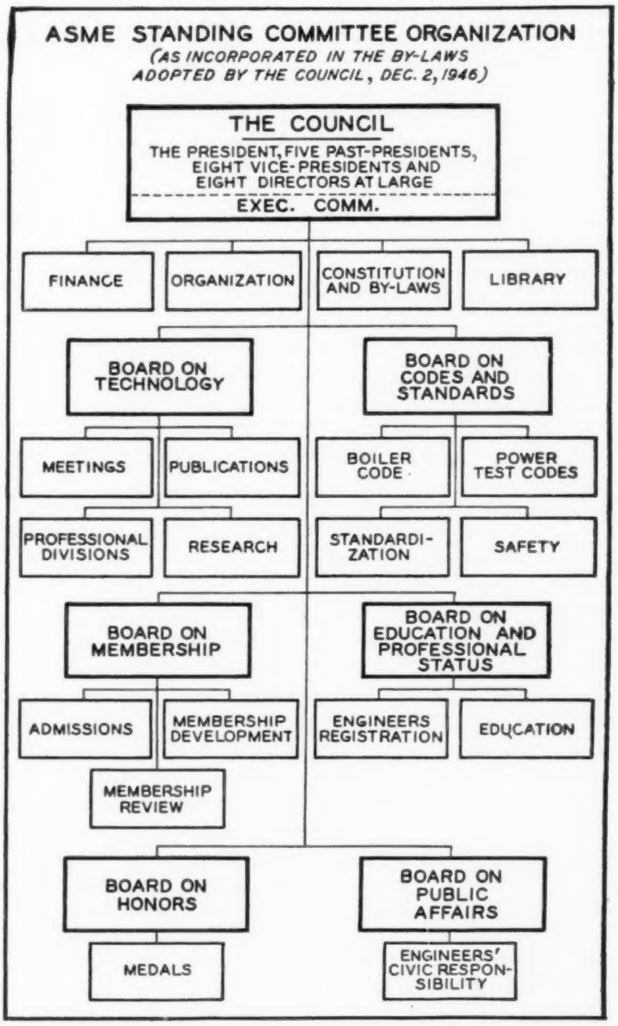


FIG. 1 A.S.M.E. STANDING COMMITTEE ORGANIZATION

(As incorporated in By-Laws adopted by the Council, Dec. 2, 1946.)

The A.S.M.E. Constitution, By-Laws, and Rules are being reprinted and will be available shortly with the changes in the By-Laws described in this article.—EDITOR.

function relates to the education of engineers at all levels where formerly its field was limited to training in industry. A new project assigned to this Board at the 1946 Annual Meeting included the development of a program for the engineer in training, the interpretation of the studies on earnings and collective bargaining being made by the Engineers Joint Council, and the recommendation of proper Society action.

The Board on Honors and its related body, the Medals Committee, select recipients of awards, honors, and honorary memberships. The Freeman Award Committee is assigned to this Board.

The Board on Public Affairs is a new agency to carry out the Society objectives having to do with cooperation with government on engineering matters, participation in international engineering affairs, and the securing of larger participation by engineers in public affairs. One special committee, that on Engineers' Civic Responsibilities, now assigned to this Board, has had under way for some time a program designed to secure larger participation by sections and individuals in civic affairs.

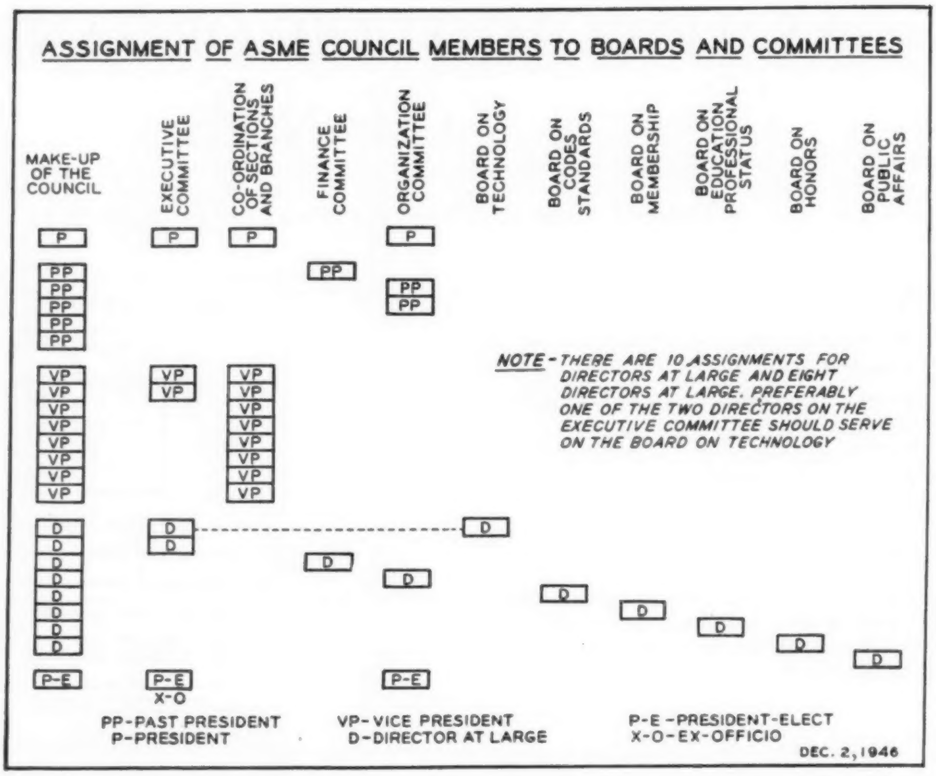


FIG. 2 ASSIGNMENT OF A.S.M.E. COUNCIL MEMBERS TO BOARDS AND COMMITTEES

Fig. 2 shows how the individual members of the Council serve on boards and committees. Except for the two vice-presidents who also serve on the Executive Committee of the Council, the vice-presidents are free to devote their efforts to serving the members in the regions in which they are responsible. There are ten assignments for the eight directors at large which means that two directors must hold two assignments. In 1947 the director on the Board on Technology and the director on the Board on Codes and Standards will also serve on the Executive Committee.

REGIONAL ADMINISTRATIVE COMMITTEES

By vote of the members of the Society the Constitution was changed in June of 1945 to provide that the Council shall consist of the President, five past-presidents, eight vice-presidents which were to be nominated by the eight regions into which the country is divided, and the eight directors at large discussed in previous paragraphs. The By-Laws adopted in connection with these changes give the vice-presidents responsibility for leadership in their regions, particularly in connection with the sections and student branches. For ease of administering the problems of the region, the By-Laws provided for regional administrative committees. Some changes were made in the scheme of regional administrative committees with the result that the plan for regional organization is now as is shown in Fig. 3.—C. E. D.

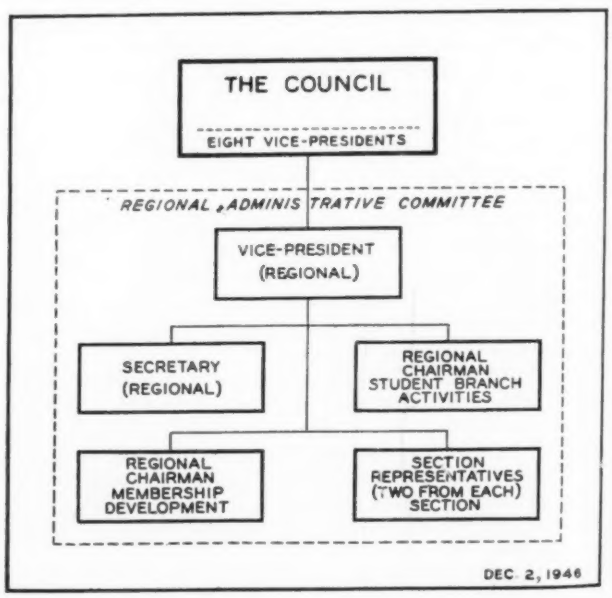


FIG. 3 ORGANIZATION OF A.S.M.E. REGIONAL ADMINISTRATION COMMITTEE

(The secretary (regional), appointed by the vice-president, acts for him in his absence or disability. The regional chairmen of Student-Branch Activities and Membership Development are appointed by the vice-president. The section representatives meet with the regional representative on the National Nominating Committee to choose candidates for vice-president from the region.)

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Improving American Production

THE technological and industrial organization that permitted the German war machine to maintain high output, despite difficulties in communications and transportation, and a shortage of skilled manpower, offers invaluable clues for improving American mass production methods, according to Dr. Todos M. Odarenko, of the Office of Technical Services, Department of Commerce.

Dr. Odarenko recently returned from Germany, where he headed the overseas Electronics and Communications Unit of the OTS Technical Industrial Intelligence Division. He was on leave of absence from the technical staff of the International Telephone and Telegraph Company, New York, N. Y.

Declaring that the utilization of German production techniques has already saved American industry an inestimable amount of time and money in independent research and experimentation, Dr. Odarenko urged businessmen and manufacturers to take full advantage of the unparalleled opportunities for studying German scientific and industrial developments.

He pointed out that industry should send more investigators to Germany at once, since the possible signing of a peace treaty and the return to more normal conditions in Germany may eventually bring an end to American investigations.

Though the fundamentals of many German developments are not unknown to American engineers, their successful wide-scale application to production methods and processes is novel. Obtaining exhaustive knowledge of the "know-how" for similar wide-scale use in America obviously is of paramount importance.

To speed production, the German electronics and communications industries reduced the amount of piecemeal assembly work by using forgings, castings, molds, and preassembled component units, according to Dr. Odarenko. For example, an ingenious machine was invented to cast radar and radio chassis complete with the partitions and supports necessary for mounting electronic components.

Previously, the chassis were stamped out of sheet metal, and the partitions and supports—angle arms and the like—for each of the many components used in a radio or radar set had to be bolted or screwed separately to the chassis. The casting machine, by combining all these separate operations into one, conserves time and labor.

A similar German development for expediting the mounting of electronic assemblies was the wide use of ceramic insulating plates with printed or painted electrical connections. Such connections eliminated the need for the conventional laborious wiring.

Thorough study of German technique also is essential for the successful American manufacture of any useful material developed or invented in Germany in recent years. Careful reading of available documents describing the composition of the material and the machinery for its production, and even detailed physical examination of both material and machinery in many cases have yielded insufficient information.

For example, American manufacturers ran into difficulty when they attempted to reproduce the German process for converting powdered polystyrene into a tough, plastic film called "styroflex." The film has excellent dielectric and mechanical properties. The Germans successfully used it as insulating material in high-frequency cable and as a substitute for mica shoots in high-precision fixed capacitors. American manufacturers, however, found that the plastic film they produced lacked the uniformity of thickness and the stability and flexibility of the German-made product. A special team of experts had to be sent abroad to obtain additional information from the Norddevtsche Seekabelwerke, at Nordenhaus, the company that perfected the polystyrene conversion process.

Dr. Odarenko pointed out that a little time spent in investigation before going into production will more than repay a manufacturer for the expense of sending an investigator to Germany.

Manufacturers interested in sending investigators to Germany should communicate with John C. Green, director, Office of Technical Services, Department of Commerce, Washington 25, D. C.

Science City

PLANS for a "science city" within Harvard's university city, Cambridge, Mass., were announced on Nov. 2, 1946, by President James B. Conant, and are reported in *Science*, Nov. 22, 1946. The scientific and technological resources of Harvard will be integrated with new buildings and equipment under a new co-ordination of scientific staffs. A central Science Center Building, now in the process of blueprint planning, will become the axis of the science city.

Centralization of teaching, study, and research facilities in various scientific departments, now widely spread, will enable many to operate under one roof. In several instances existing laboratories will be joined to the new science structures.

In the announcement, Dr. Conant stressed the expectation that through this new liaison of scientists and the sciences, Harvard will play an even greater part as a science school in the technology of tomorrow.

It is hoped that the first section of the Science Center Building may be built in the near future with funds now available. An effort is being made to raise the necessary funds and endowment for the entire structure. According to tentative plans, this structure will be about 500 ft long and four or five stories high, with a frontage on Oxford Street opposite the Mallinckrodt Chemical Laboratory, outside the yard. The building eventually will house all of the branches of applied physics, geophysics, geology, mathematics, and undergraduate instruction in astronomy, among other groups.

President Conant said that the construction of this large new science building will complete a science center embracing most of Harvard's scientific activities outside the area of medicine.

Already located within a convenient radius is a varied and well-equipped group of buildings for the fundamental study of the phenomena of physics, chemistry, and biology, and their application to astronomy, the earth sciences, and engineering.

The first section of the new science building will be devoted to laboratories required for the new Department of Engineering Sciences and Applied Physics, which has been organized under the Faculty of Arts and Sciences.

Harvard University's contribution to both pure and applied science is in the process of being made commensurate with challenges of the postwar world. The erection of the Computation Laboratory and the Nuclear Physics Laboratories is a first step in this direction.

The new science building, when completed, can be considered as the focus of the integration of Harvard's varied activities in natural science. President Conant hopes that funds for the construction and endowment of the entire structure may be forthcoming in the not too distant future from a group of interested donors.

Research

IN an address which he gave recently at the University of Illinois and which was reported in the November, 1946, issue of the *Report*, Capt. R. O. Conrad, director of the Planning Division of the Office of Naval Research, pointed out that scientists participated in the war effort to an unparalleled degree. He defined research as "the search for new knowledge of nature," and development as "the application of knowledge." He then described the functions of the National Defense Research Committee and affiliated activities and he declared that never in history were scientists in such urgent demand.

To encourage research, about 200 research contracts covering more than 400 projects, totaling about 22 million dollars, are in effect with outside activities through the Office of Naval Research. More than three quarters of this volume is placed with universities and colleges.

Captain Conrad explained that this is a program of considerable magnitude. Yet it is limited by the funds available and by other considerations. The Navy can never be the sole support of research in any university, nor should it be. The needs for research are so great, and its promise is so rich, that full support from all sources is called for.

Pointing to nuclear physics, Captain Conrad revealed that an immediate objective of the Navy is atomic energy for ship propulsion. The United States Navy is the largest user of power in the world and also the largest technical organization—through its shipyards and its traditional interrelationships with industry.

In conclusion, he said that "it is becoming impossible to distinguish what we mean by military preparedness. Research in every field of science will yield developments of importance to the national security. We in the Navy are well aware that today's weapons are tomorrow's discards. We must continually encourage and support the swift advances of science and interpret it in terms of the national defense.

"Atom bombs, guided missiles, bacteriological poisons, and all their hellish brethren and potential offspring have created vast fears and doubts in the minds of men. The old securities of space and time are vanishing. Our powers of self-destruction appear like a baited trap which mankind is powerless to evade. Where is the new hope? Where is the new security?

"The answer is in knowledge. The renaissance of research, to which the Navy is proud to contribute, can create the new knowledge and stimulate the education which are the foundations of a better world. In a more limited sense, the study of our research results will reveal the evil possibilities against which we must guard ourselves, and this is a natural responsibility of the Navy. But in a broad sense, the common enemy of mankind is ignorance. We must bend all our energies to learning more and more of ourselves and the world around us. Research to create knowledge, and Education to spread it to all people, are the basic safeguards of civilization, and the only weapons which will succeed against ignorance, our ultimate enemy."

Additive Lubricating Oils

AT the Aviation Meeting, held in Los Angeles, Calif., last year, sponsored by the Aviation Division of The American Society of Mechanical Engineers in co-operation with the Southern California Section of A.S.M.E. and the University of California, W. E. Kuhn, manager, technical and research division, The Texas Company, New York, N. Y., and J. E. Fields, Beacon Research Laboratory, The Texas Company, Beacon, N. Y., presented a paper, "Additive Type Lubricating Oils for Aircraft Engines," in which they discussed the major factors involved in aircraft-engine lubrication and the methods available for improving engine maintenance through improved lubrication. An abstract of their paper follows:

The current trend of aircraft-engine design toward higher power outputs plus a desire toward further increased time between overhaul periods and lower operational costs have placed an additional severe strain on the lubricating oils employed. To meet this problem the development of aircraft-engine oils which will yield improved and prolonged engine operation under existing and even more severe operating conditions is of prime necessity. It appears that the proper application of additive agents to the problems at hand can and will achieve this goal.

Disregarding numerous mechanical variables involved arising through engine operation and maintenance, the major factors involved in aircraft-engine lubrication are: (1) Temperature distribution in the lubrication system; (2) pressure distribution between moving surfaces; (3) composition of blow by and exhaust atmospheres; (4) metallic varieties encountered in the lubrication system.

Two avenues of approach present themselves as possible methods of improving aircraft-engine lubrication. These are: (1) Improvement through change in crude source or refining techniques; (2) improvement through use of proper additives.

Probably the most promising method of achieving improved

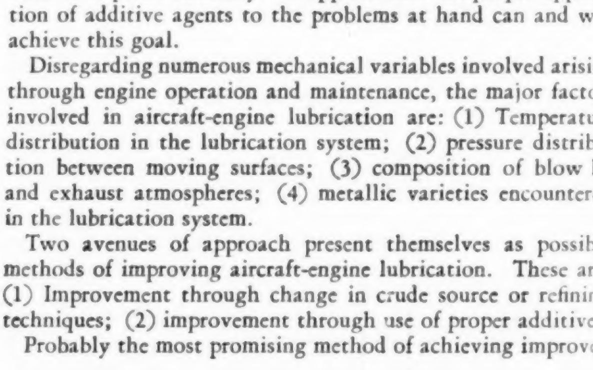


FIG. 1 TYPICAL VALVE-GUIDE CORROSION AS FOUND IN FLIGHT AND LABORATORY TESTS

aircraft-engine lubrication is by the use of additive agents. In this respect, after due consideration of the major factors involved, it appears to be possible to choose the proper types of chemical-addition materials which, when incorporated into present-day mineral oil, will reduce aircraft-engine maintenance and operating costs through lengthened engine-overhaul periods made possible by general engine-lubrication improvement. Additives should be chosen which will best accomplish the following: (1) Increase heat stability thereby reducing deposits and ring sticking; (2) improve E. P. and wear characteristics; (3) decrease accumulation of lead deposits; (4) improve low-temperature operation; (5) decrease possibility of valve-guide corrosion; (6) reduce possibility of bulk-oil deterioration and bearing corrosion; and (7) decrease possibility of corrosion (rusting) of engine interiors during periods of engine idleness.

In accomplishing the choice of the proper additives, two basic facts must be kept in mind: (1) In general, a given additive may not be effective over the entire temperature range encountered; and (2) if several additives are employed, they must be entirely compatible. Thus in the first case a knowledge of the temperature range wherein the lubricant must work is essential.

An important point to realize in the development of additive materials for use in aircraft-engine lubricants is that the mere fact that certain additives have proved themselves to be outstanding in heavy-duty oil service does not imply that they will be useful in aircraft applications. There seems to be a tendency to speak of the use of "detergent" oils in aircraft applications with backgrounds based on heavy-duty oil-additive experiences. While these experiences are undoubtedly of value, the obviously different operating conditions of the engine types in question present entirely different problems; for example, the absence of large amounts of sooty combustion products during aircraft-engine operation as compared to Diesel-engine operation, and the absence of high rates of oil oxidation such as are encountered in heavy-duty gasoline-engine service.

Although many types of laboratory tests, both physical and engine, can be used in the development of a new oil, the final and only proof of its entire suitability and improvement lies in full-scale engine and flight testing. The oil to be tested meets many types of service which are obviously impossible exactly to reproduce in the laboratory and under these conditions it is possible and highly desirable to discover any new adverse effects which might materialize.

In general, laboratory-engine results agree quite well with full-scale experience with respect to general engine cleanliness.

Airline flight tests amassing more than 3000 hr per oil on engines of approximately 1000–1200 hp indicated some improvement with the additive oil as inspected at the 700-hr overhaul periods. Winter operation tended to promote low-temperature sludge occurrence with the test oil.

Test-stand operation on lower-powered engines showed a greater degree of improvement favoring the additive oil, however, for much shorter periods of time.

Another oil containing only an E.P. improving agent gave normal operation both in extensive flight use and laboratory tests.

It was shown that although the additive oil apparently gave better conditioning service to piston rings during run-in periods, extended use at rated power led to severe ring wear similar to that experienced with the base oil. Although giving good performance in flight experience with respect to ring and cylinder wear, the oil did exhibit severe cylinder wear when run for 50 hr in a test-stand six-cylinder, 200-hp air-cooled engine.

In recent airlines testing, corrosion of alloy exhaust-valve guides causing excessive clearances which resulted in the valves hanging open because of wobbling in the guides, or collecting deposits causing misfiring or loss of power, has been encountered. This necessitated the removal of an excessive number of cylinders prematurely for the purpose of guide replacements. Immediate research on this problem has produced much information regarding the cause of and conditions accompanying such corrosion.

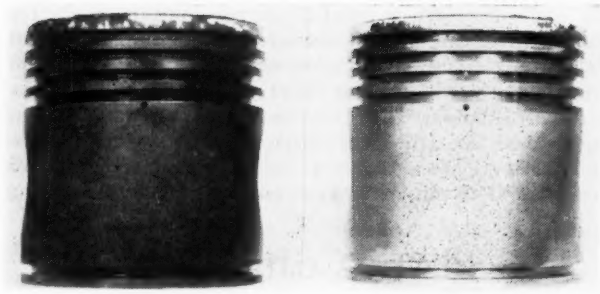


FIG. 2 PISTONS TESTED IN A SINGLE-CYLINDER C.F.R. SUPERCHARGED ENGINE OPERATING FOR 50 HR

(*Left:* Straight mineral oil used. *Right:* Straight mineral oil plus an additive used.)

Fig. 1 illustrates valve-guide corrosion as found in flight tests and as produced in laboratory engines.

Research has shown that factors entering into such corrosion are: (1) Rocker-arm oil-box temperatures; (2) valve-guide temperatures; (3) valve-guide composition; and (4) oil composition. High-temperature stability of lubricating oils, and especially of their additives, appears to be of first importance.

The existence of deposits aggravated by low temperature existing in certain sections of the airplane engine such as the nose section is a prevalent problem. While the cause and cure of such sludges is mainly mechanical and operational, laboratory engine tests are in use which will distinguish between oils which will promote the formation of low-temperature sludge and those which will tend to lessen its formation. In the main, if proper oil temperatures are maintained, such problems will not be troublesome. However, if this is not the case, care must be taken when compounding an additive oil not to introduce those materials which may aggravate this condition.

The possible problem of alloy-bearing corrosion is also one which requires preventive recognition. Thus while bulk-oil temperatures existing in practice are below the point where excessive oil deterioration takes place, the possibility exists that: (1) Higher temperatures may be introduced in engines of future design; (2) additive materials themselves may promote bearing corrosion; or (3) the use of coarse-structure alloys may lead to possible bearing corrosion. Here again it is highly desirable to attain that extra degree of protection by the development of lubricants which are noncorrosive to such bearings even under conditions of high rates of oil deterioration. Laboratory tests for the evaluation of bearing corrosion are in use and are well known.

With the recognition of the many problems involved, and following the development of laboratory tests which correlate well with full-scale performance, outstanding progress has been made with respect to developing new and improved additive-type aircraft-engine lubricants.

In engine testing two improved additive-type oils compared to the straight mineral oil, failure was encountered at 25 hr for the straight mineral reference oil because of excessive wear. At these points, deposit demerits were about the same for both

oils with improvement noted in the running time of the test plus improved ring-sticking characteristics for the additive oil. Valve-guide corrosion was obtained with this oil. The improved additive oils were run for 125 hr and the test terminated without oil failure. Thus outstanding improvement is noted for these oils not only in the greatly increased running time but also in absence of ring sticking, wear, and a decrease in deposit demerits. Both oils are prone to cause valve-guide corrosion.

Plastic-Coated Pipe

DEVELOPMENT of plastic-coated steel pipe resistant to the corrosive conditions often encountered in oil-well drilling has recently been announced by the Spang-Chalfant Division of The National Supply Company, Pittsburgh, Pa. It is reported that the unique properties of plastic-coated pipe promise to open broad fields for its use in many other industries, including home and industrial construction.

During field tests of the new plastic-coated drill pipe which were performed intermittently over the last few years, several oil wells were drilled with a total of more than 60,000 ft of hole. These tests have shown that plastic coating will prevent many failures of pipe during drilling by protection of the surface against corrosion pitting.

Drill pipe, the majority of it $4^1/_2$ in. in diameter, first is shot-blasted on the inside. The pipe then is upended in a rack and the liquid plastic is forced up the inside of the pipe until it has reached the top. Then it is drained slowly so that no air bells or streaks are formed. After a short drying period at normal temperature, the pipe is placed in an oven and the plastic coating is baked on. Four successive coatings of the plastic are baked on the pipe.

Only the inside of the pipe is coated for oil-well drilling because it has been found that almost all corrosion fatigue failures develop only from the inside. This is because the pipe turning in the hole keeps its outside surface burnished by rubbing against the wall of the hole. For most other applications the pipe probably would need to be coated on both the inside and outside surfaces.

Shortening Eyebars

INVESTIGATION carried out by a committee of the Welding Research Council, a project of the Engineering Foundation, New York, N. Y., has found that the shortening of eyebars by heating with an oxyacetylene torch does not materially affect the fatigue strength of the bars, according to a preliminary report on the research. This research has therefore validated as safe practice, the most economical method of shortening eyebars. It is estimated by the Association of American Railroads that if the method were used in tightening all the loose eyebars, the resulting saving would be about one million dollars per year.

Eyebars are metal bars with a hole for a pin or bolt at one or both ends and are used in truss bridges. Comparable tests on representative eyebar specimens shortened by other more costly methods showed that the fatigue strength (that is, the ability to withstand repeated loadings) of such specimens varied from 35 to 50 per cent of the fatigue strength of the original eyebar.

The report states, as background for the research, that the pins and pinholes in the eyebars of many old pin-connected truss bridges have been subjected to a high rate of wear resulting from the operation of heavy locomotives at high speeds. In spans of this type, many of the eyebars have become so loosened through wear that they are carrying very little, if any, of the total stress in the member. These eyebars have been known to rattle for several minutes after the passage of a train. In some cases one bar of a two-bar member has carried as much as 97 per cent of the total load.

Various methods have been used in the past in an effort to tighten loose eyebars; however, they were either too expensive, or much of the fatigue strength of the original section was lost, or the heating equipment employed was too cumbersome and required considerable time to heat the eyebars.

During the past few years several of the railroads have used oxyacetylene torches to heat the required area of the eyebar. It is reported that the use of these torches has not only reduced the time required to heat the eyebar to the desired temperature, but also insures a more uniform temperature of the heated area.

In addition to the description of the eyebar-shortening method by use of oxyacetylene torches, the report includes a table showing the variation in live-load stresses in eyebar-truss members, the results of fatigue tests on eyebars that had been shortened and eyebars that had not been shortened, the results of tests on the effect of temperature on the physical properties of steel, and a description of the method of determining the dead load or initial stress in eyebars.

It is stated in the report that the flame-shortening of eyebars does not have any appreciable effect on either the fatigue or the static strength of the bars. The equipment required is standard for bridge and building gangs, with the exception of the clamps and a pyrometer. Costly train delays are eliminated as only one hour is required to complete the work on one bar.

Axial-Flow Turbomachines

A BOOK, "New General Theory of Multistage Axial-Flow Turbomachines," written by Dr. Walter Traupel in German, was considered of such interest and value to American compressor designers that Dr. C. W. Smith, General Electric Company, has translated it into English. The Navy Department, Bureau of Ships, Washington, 25, D. C., is reproducing the book.

This work is a logically arranged treatise covering by a single calculation procedure the design of both axial-flow compressors and axial-flow turbines. The general method of attack may be described as the application to full-scale design of coefficients obtained by model grid tests.

The first chapter outlines the objective and nature of the new theory and gives the general definitions and notation required. Chapter 2 covers the elementary theory of frictionless flow through the stages of turbomachines, and defines and explains the characteristic quantities on which the application of the theory is based.

In Chapter 3 the theory of grid testing is taken up. The grid coefficients used are defined, and their physical significance is explained. Chapter 4 shows how these coefficients are used in calculating the efficiency of a single stage, and Chapter 5 gives the method of determining the dimensions and efficiency of a multistage machine on the basis of the single-stage efficiency.

The first five chapters constitute in themselves a completely workable theory which is sufficient for most practical cases. Chapter 6, however, gives a somewhat more detailed theory with refinements which were neglected in the earlier chapters, and with fewer limitations from basic assumptions. In this chapter, also, the merits of a design based on "vortex flow" are compared with those of a design based on "symmetric velocity diagrams at radii." On the basis of the analysis made, it is concluded that the performance would not differ very much if neither design is such as to result in flow separation from the blades.

Supersonic Aerodynamics

THE Tenth Annual Wright Brothers Memorial Lecture on the subject, "Supersonic Aerodynamics—Principles and Applications," was given before the Institute of Aeronautical Sciences in the auditorium of the U. S. Chamber of Commerce, Washington, D. C., Dec. 17, 1946, by Dr. Theodor von Kármán, member A.S.M.E., director, Guggenheim Aeronautical Laboratory, California Institute of Technology.

A technical abstract of Dr. von Kármán's lecture prepared by Dr. H. S. Tsien, associate professor of aeronautical engineering, Massachusetts Institute of Technology, follows:

Until recently the study of the motion of bodies with velocity faster than sound belonged to the realm of ballistics. As a matter of fact, when the science of modern aerodynamics was developed a few decades ago, most theories were based on the assumption that air can be considered an incompressible fluid. It was shown that the error in the computation of air forces produced by the motion of an airplane is about one half times the square of the ratio between flight velocity and sound velocity which is 760 mph at normal conditions. This ratio is known as Mach's number. If the flight velocity is 150 mph, the error is about 2 per cent. As the flight velocity of airplanes increased, it became necessary to consider the so-called "compressibility effects."

A few years ago the very large drag at velocities near to the sound velocity or for Mach numbers near one, led to the belief that sonic velocity was not penetrable. This is now proved to be fallacious as new propulsion devices are developed to produce very large thrust and new design concepts are evolved to reduce the drag. It is the second new advance in aeronautical science, the increase in efficiency of supersonic aerodynamics, that form the main topic of the Lecture.

The basic rules of supersonic aerodynamics are entirely different from the basic rules of subsonic aerodynamics. These new rules are:

(1) The rule of forbidden signals. Since a slight pressure change propagates in the air with sound velocity, it is evident that the effect of pressure changes produced by a body moving with a speed faster than sound cannot reach points ahead of the body. As one may say, the body is unable to send signals ahead. It is seen that there is a fundamental difference between subsonic and supersonic motion. Consider the case of stationary motion, for example, the uniform level flight of an airplane. Then the pressure signal ahead proceeds with sound velocity minus flight velocity relative to the airplane whereas a signal backward travels with a speed equal to the sum of the flight and sound velocity. So the distribution of the effects is no more symmetrical—nevertheless every point in the space has been reached by a signal provided the flight started from an infinitely remote point. (For this consideration we neglect viscosity, i.e., the absorption of energy in the air.) As one can easily see, that is not the case in supersonic flight and one obtains the second rule.

(2) The zone of action and zone of silence. Consider the simplest case of a point sound source. If the source is at rest the pressure effect spreads as spherical surfaces of even spacing. If a point source is moving faster than sound, then all action is restricted to the interior of a cone which includes all spheres of pressure effects. The outside of this cone can be called the zone of silence. It is easily seen that the trigonometrical sine of the half vertex angle of the cone is equal to the reciprocal value of Mach's number. This angle is called Mach's angle. The cone which separates the zone of action from the zone of silence is called Mach's cone.

(3) The rule of concentrated action. This rule expresses another characteristic difference between subsonic and supersonic motion, which concerns the distribution of the pressure effect in the space relative to the moving body. In the subsonic case one finds that the pressure effect not only decreases with increasing distance from the source, but is also dispersed in all directions. In the case of a body moving with supersonic velocity, the bulk of the effect is concentrated in the neighborhood of the surface which limits the zone of action.

With these basic rules one can understand both the mechanism of drag formation and the mechanism of lift production. The drag can be divided into wave drag and induced drag. The wave drag is characteristic of supersonic flow which represents the energy expanded in creating the concentrated disturbance on the surface of Mach cones. The induced drag is the result of the production of lift and is represented by the kinetic energy of the downward motion of air mass created to counterbalance the lift force. Therefore induced drag is present also in subsonic flow. It is the wave drag that is troublesome and raises the over-all drag of a supersonic aircraft. It will be shown that by sweeping back the leading edge of the wing, the wave drag can be greatly reduced. Thus the over-all lift over drag ratio in the aerodynamic efficiency of the wing can be increased to a value comparable with the highly efficient subsonic wings. This then opens the door to supersonic flight.

Synthetic Rubber Booklet

A FIFTY-PAGE booklet, "Five Years of Synthetic Rubber," has been released recently by the United States Rubber Company, for students, educators, and interested members of the public.

In simple language the booklet tells of the growth of the synthetic rubber industry and gives an appraisal of its importance today in the manufacture of rubber products.

The various types of synthetic rubber are identified and described in considerable detail and an impartial analysis of their properties is shown in tabular form.

For the chemistry student a technical appendix is included which gives the chemical structure of rubber and the synthetic rubbers. A useful glossary of terms used in the industry is added.

The booklet is available upon application to the Publicity Department, United States Rubber Company, Rockefeller Center, New York 20, N. Y.

Cloth Treatment

A PROCESS to prevent moth damage to clothes by impregnating them with DDT has been perfected by the Whitemarsh Research Laboratories of the Pennsylvania Salt Manufacturing Company and soon will be made available to the public through dry cleaners, it was announced recently.

The new method is claimed to thoroughly impregnate clothing with DDT without affecting the cloth in any way. It involves a mixture of DDT with an adsorbent powder and a pump percolator machine which dissolves the DDT in just the right amount in the dry-cleaning solvent. The machine sprays this solution on the clothes in the dry-cleaner's extractor in such a way that the treating solution thoroughly saturates the garments, so that after drying, minute amounts of DDT are deposited on nearly every fiber.

Tests show that the DDT actually kills or repels insects, such as clothes moths, carpet beetles, and silver fish, that venture to attack garments.

FIG. 3 A RESEARCH CHEMIST IS SHOWN INSERTING A POROUS CLOTH BAG CONTAINING DDT AND ADSORBENT POWDER IN THE CHARGING TOWER OF THE NEW PROCESS MACHINE

(Cleaning solvent, pumped through these bags, picks up the proper amount of DDT and carries it through clothing in the extractor (*left*). The adsorbent powder also removes impurities from the solvent passing through it.)

It was found that DDT applied by this process protects clothes from insect damage between even infrequent dry cleanings. Most of its strength is retained through a number of washings. One piece of wool, treated two years ago, is reported to have remained untouched by carpet beetles although it has been kept enclosed with beetles most of this time.

Complete tests, both at Whitemarsh and the National Institute of Dry Cleaning Laboratories, proved that the cloth is in no way injured by the DDT. Colored fabrics showed no indication of color change and no more tendency to fade than untreated samples. No odors were detected in treated cloth and the DDT produced no change in tensile strength, "feel," or other physical characteristics.

The composition is packed in porous cloth bags which can be inserted in the charging tower of the process machine.

Clothes are treated with DDT during the regular dry-cleaning process. The garments are dry-cleaned, then transferred to the extractor and centrifuged in the usual manner.

The treating machine, a mobile unit, is then connected to the extractor at two points—a flexible hose with a suitable spray head is mounted in the top of the centrifuge and another flexible hose is connected to a two-way valve at the extractor drain outlet. This two-way valve permits the solvent from the first extraction to return to the regular dry-cleaning system in the usual manner. At the end of this extraction the valve is turned so that as the DDT solution is sprayed on the clothes and is extracted, it returns to the treating machine for re-use and recharging.

In the machine, a pump forces the solvent through the porous cloth bags in the charging tower, dissolving DDT until the concentration in the tank is sufficient. This solution then is pumped through the flexible hose and spray head in the extractor lid and sprayed on the load while it is being centrifuged. The concentration, which must be maintained at the correct percentage, is easily determined by specific gravity.

The system is recharged by adding one or more cloth bags to the charging tower of the machine. The adsorbent powder acts both as a carrier for the DDT until it is dissolved by the solvent and as a purifier of the solvent, since it takes out coloring matter, fatty acids, fatty acid decomposition products, and other foreign matter picked up from clothing by the solvent.

German Scientists

AN article in *The Iron Age*, Dec. 12, 1946, reveals that 86 scientists who were leaders in their specialties in Germany and Austria during World War II, are working at Wright Field, Ohio, headquarters of the Air Materiél Command, assisting A.M.C. personnel in research programs.

The German scientists work under special contracts as alien civilian employees of the War Department. They entered into the contracts voluntarily.

Salaries of the German scientists range from \$2.20 to \$11 a day and are paid to the scientists' banks or families. While on temporary duty in the United States they are paid an additional \$6 per diem to cover living expenses. Their living quarters are comparable to those of junior officers of the U. S. Army.

Some indication of the high mental caliber of the group can be had from the fact that Dr. Bernard Goethert, formerly chief of high-speed aerodynamic section at DVL, Berlin-Aldershof, is presently engaged in testing and correcting the Wright Field 10-ft wind tunnel, and Fritz Dolhoff, who invented and designed the Dolhoff jet-propelled helicopter which is one of the oddest projects at Wright Field at the moment, is also a member of the group.

Dolhoff's helicopter, which may contribute substantially to the development of rotor blade aircraft, is so designed that rotor blades are revolved by the exhaust from a jet engine, piped to the blade terminals. In this way the helicopter can hover or go up and down. Forward speed is attained by tipping the tail elevators.

A pusher-propeller at the rear of the fuselage provides a slip stream allowing easier directional control. This is powered by a small motor which is carried in addition to the jet engines, but neither engine directly propels the ship.

Experts believe that its speed can be greatly increased by addition of another propeller to provide forward thrust and experiments are now being conducted along these lines.

Another project on which some of the German scientists are collaborating is the ribbon parachute, one of a number of solutions to high-speed bail-out. Developed by a large staff of German scientists and originally built by a manufacturer of hatbands, the ribbon parachute was put into production for use in all German Air Force jet planes shortly before the end of the war.

Possessing the advantage of low opening shock and descent without oscillation, the ribbon parachute enables fighter pilots to pull off extraordinary diving maneuvers, and one such chute attached to each wing will stop a spin or slow a plane enough to eliminate danger to the pilot bailing out.

The ribbon parachute works as follows: When the ripcord is pulled the pilot chute springs from the pack and fills, drawing the canopy and lines from the pack enclosed in a fabric sleeve. Lines are stowed on an auxiliary panel at the skirt in such a manner that the canopy portion of the chute is trapped until the last foot of lines is withdrawn. The canopy is constructed of 144 ribbons which start at the skirt and extend upward at a slight angle to a point tangent to the vent diameter of 20 in. which causes a progressive decrease of the air spaces between ribbons until at a point about 3 ft from the vent a solid coverage of ribbons is attained.

Some of the scientists have completed their work at Wright Field and are now waiting to find out if they will be permitted

to stay in the United States and find employment in industry. Dr. Eugen Ryschkewitsch, a specialist in high-temperature ceramics, carbides, graphites, and boron, is typical of these.

Dr. Ryschkewitsch, who spent his last years in Germany in research activities, has developed a number of special materials, including a sintered ruby material which was used to some extent in Germany in the last days of the war. Sintered at a temperature slightly below 2000 C (3623 F) the sintered ruby material when used for dressing grinding wheels will, it is said, give results closely approaching diamonds. The material can be extruded, pressed in a variety of shapes before firing, and is 5 to 10 per cent harder than aluminum oxide or corundum, according to the German scientist.

Dr. Ryschkewitsch, who invented a special furnace for firing at high temperatures, believes the ceramics industry has a tremendous future. The sintered ruby material, according to him, possesses some physical properties which are superior to the carbides, and despite the high cost of firing, is, he asserts, infinitely cheaper.

Inverted-Type Engine

A JAPANESE outboard marine engine of clever design used for propelling heavy barges, pontoons for bridges, and similar vessels is described in a report (PB-25824) on sale by the Office of Technical Services, Department of Commerce, Washington 25, D. C. The report is an evaluation of the engine by the U. S. Army Engineer Board, Ft. Belvoir, Va.

An unusual feature of the engine is that it is inverted—the four cylinders are below the crankshaft. Advantages from this design are a low center of gravity and a less conspicuous silhouette. It also weighs less than half as much, performs as well as, and in some respects, better than comparable American engines, the evaluators say.

The engine has a bore of 3.42 in. and a stroke of 4.375 in. It reaches maximum power at 2600 rpm. Its light weight is attained by use of sheet-metal water jackets welded to the cylinder sleeves. The report recommends a complete investigation of the engine with a view to incorporating some of its unusual features in American designs.

Synchrotron

THE synchrotron, a new and compact type of atom smasher, capable of producing a beam of 70,000,000-volt x rays, was announced recently by Dr. Herbert C. Pollock, General Electric Laboratory scientist, in a lecture before The Franklin Institute in Philadelphia, Pa.

The success of this device, said to be the first to operate in the Americas, built as part of a project sponsored by the Office of Naval Research, indicates the possibility of producing radiations of much higher energies for atomic study, with greater economy than with earlier equipment.

The synchrotron as originally proposed was invented independently by V. I. Veksler, in Russia, and E. M. McMillan of the University of California where a 300,000,000-volt synchrotron is under construction.

The new atom smasher in its present form combines certain features of the cyclotron with those of the betatron, another type recently developed. While the cyclotron is used for accelerating protons (positively charged atomic particles), the synchrotron and betatron both are used for accelerating electrons which have negative charges.

The betatron has been developed principally at the University of Illinois and at the G-E laboratory where one emitting 100,000,000-volt x rays is now operating. (A description of a 20-million-volt betatron, built by Allis-Chalmers, and recently unveiled at the Picatinny Arsenal, Dover, N. J., appears on pages 34 and 35 of the January, 1947, issue of MECHANICAL ENGINEERING.)

Though the 70,000,000-volt radiation from the new synchrotron has more than two thirds the energy of that from the betatron, the machine is smaller, weighing only about 8 tons. Thus it offers fascinating possibilities for going to much higher voltages with less weight of iron. (The 200,000,000-volt cyclotron recently placed in operation at the University of California, weighs about 4000 tons.)

The new machine combines both betatron and synchrotron operation, and was invented jointly by Dr. Pollock and his associate, W. F. Westendorp. At the beginning of each cycle of operation, which is repeated 60 times per sec, the acceleration of electrons starts off as in a betatron and is continued as in a synchrotron. The electrons are injected from a hot filament and are speeded as the magnetic field builds up. When they have acquired energies of about 2,000,000 volts, they are moving at 97 per cent of the speed of light—186,000 miles per sec. They cannot go faster than light, so any further increase in energy is manifested as an increase in mass.

A glass "doughnut," having an outside diameter of 27 in., is located between the poles of the electromagnet. This is connected with an electrical oscillator, essentially a radio transmitter operating on a frequency of 163 megacycles or a wave length of a little less than two meters. After the electrons have reached 2,000,000-volt energies, and are moving practically at constant speed, nearly that of light, the oscillator is automatically turned on. In the oscillating electric field, the electrons quickly get into step and come around in groups, receiving an

FIG. 4 DR. HERBERT C. POLLOCK (*below*) AND DR. FRANK R. ELDER MAKE ADJUSTMENTS TO THE 70,000,000-VOLT SYNCHROTRON

increase in energy each time they go past. It was explained that this takes care of another limitation to the betatron. When electrons are moving at energies of many hundreds of millions of volts, they actually radiate away much of their energy, just as do the electrons moving back and forth in a radio-antenna system. With the synchrotron, however, there is automatic compensation. If an electron loses energy, its orbit contracts, and the next time it returns to the gap a little sooner. This causes it to get more than its normal quota of energy.

After the electrons have reached their full velocity the oscillator is turned off. All the electron orbits contract. As a result the electrons hit a tungsten target, generating x rays.

Silica Removal

A NEW process for removing dissolved silica from boiler feedwater has been developed and was described by Walter Leaf, research technician, Denver and Rio Grande Western Railroad Company, Denver, Colo., at a Power Division technical session during the 1946 Fall Meeting of The American Society of Mechanical Engineers, held in Boston, Mass.

In November, 1943, the Denver and Rio Grande Western Railroad Company started research on the problem of economically producing a better quality of water. It was discovered in the process of the investigation that hydrous ferric oxide formed from the rusting of steel lathe turnings or the like in the presence of the water to be treated was very effective in removing the silica, probably by absorption. A plant to treat 30 gpm was built at Alamosa, Colo. A wood-stave tank 5 ft in diameter and 7 ft high to hold steel shavings, collection sump, pump, and settling tank were the essential features. Alum feeding equipment was provided. The water was sprayed over the steel which should have rusted rapidly, but did not. Some silica removal was effected, the effluent containing around 3.5 grains per gal of silica, which was considered not sufficiently good.

After further investigation, which included operation of small pilot plants in the laboratory and at Alamosa, the wood-stave tank was replaced by one 8 ft × 8 ft, with an air manifold in the bottom, entrance pipes to introduce the water near the bottom, and an overflow pipe.

For a year all possible schemes to accelerate the rusting were tried with only mediocre success. The water at Alamosa contains 3.5 grains of sodium bicarbonate per gal which was largely broken down to sodium carbonate by aeration. Thus the pH of the water flowing through the tank was increased to about 9.0 which was thought to give protection to the iron. Consequently, the water was pretreated with aluminum sulphate or sulphuric acid in varying amounts, or carbon dioxide was blown in to reduce the pH. A pH of as low as 5.5 in the effluent did not create a corrosive condition. Based on the amount of iron in the tank and an assumed average size of shaving, it was calculated that there were nearly two acres of surface area of iron in contact with the approximate 2000 gal of water in the tank.

Additional air manifolds were driven into the tank to admit large blasts of air in an attempt to loosen whatever rust might form, offering a fresh iron surface to corrosion, to no avail.

The plant was operated intermittently for a few days or a week at a time, with days or weeks between schemes. When a new one was tried, regardless of what it was, sufficient rust had accumulated during the period of shutdown so that the effluent was down to one or two grains of silica for about a day, but soon increased to 3.5 or more. The surprising thing was that after three or four days of operation, even with a pH of 6, the water would come through this mass of steel shavings as sparkling clear as when it entered. Even large intermittent blasts of air failed to dislodge any rust. Complete neutralization of the alkalinity of the water with sulphuric acid likewise failed to create a corrosive condition.

A pilot plant operated on Denver tap water of 6.5 grains per gal hardness, 4.0 methyl orange alkalinity, and 0.7 grains silica produced rust in large quantities. The pH was 7.6 and was not much affected by aeration, there being no sodium bicarbonate in this water. The major difference between Denver water and Alamosa water after pH reduction was in the silica content, and it was finally decided that the high silica content must form a protective coating over the steel shavings, preventing further rusting. This was fairly well proved by running Alamosa water from which the silica had been removed, through a freshly prepared bed of shavings. A reasonably large quantity of rust was obtained. The theory is also well confirmed by the fact that sodium silicate has been used in municipal water supplies to protect the interior of iron pipe lines, with good results. So it seemed that high-silica waters could not be treated with steel shavings unless the mass was very large.

It was known that tin-plate scrap rusts rapidly because of electrolytic action between the tin and the iron. But no tin-plate scrap was available at Alamosa. Copper scrap mixed with the steel to provide electrolytic action was not effective as the action was too localized. Finally, the use of cast-iron freight-car-wheel borings was investigated in small pilot plants in the laboratory and at Alamosa. Cast iron contains particles of free carbon, which are electronegative to iron, so that electrolytic corrosion of the chips is very rapid. Cast-iron pipe has a good record of corrosion resistance, but there is a protective coating of high-silicon iron, formed from the sand mold, over the surface of the pipe. Once this coating is penetrated, corrosion of the cast iron may be rapid.

The cast-iron chips produced rust at a very high rate, even with Alamosa water, so several feet of steel turnings were dug out of the top of the wood tank, and cast-iron chips from the wheel plants were put in. Immediately, the silica content of the effluent dropped down to 0.7 grains per gal.

It was feared that the chips might cement themselves together to form a more or less solid mass, and this actually happened. At the end of two weeks' operation, the silica was up to 1.5 grains, and after a month, 2.0. The chips were loosened with a garden fork every day, and by this process the silica was kept at approximately 2 grains per gal.

The cast-iron chips were put into service in January, 1946. Alum was fed into the sump at the rate of about 4 grains per gal, but the equipment was not reliable and coagulation was not always good. Consequently, it was feared that the ferric oxide carried to the boiler might deposit on the tubes as scale.

In September, 1945, a new 350-hp water-tube boiler had been put in service. When the cast-iron treatment was started, the use of magnesium sulphate was discontinued. Previous to the use of cast iron, the boiler water tested 85 grains T.D.S., 24 grains methyl-orange alkalinity, 32 causticity, and 30 grains silica. This analysis showed 8 grains of sodium hydroxide and 16 grains of sodium carbonate per gal. The sodium hydroxide of course comes from the breaking down of sodium bicarbonate and is the expected result. After the silica-removal plant was put into service, the typical boiler water showed no sodium hydroxide, around 6 grains of sodium bicarbonate, 16 grains of sodium carbonate, and 20 grains of silica, which is an unusual analysis. It was found by laboratory investigation that the hydrous ferric oxide carried into the boiler when coagulation was poor was probably responsible. Just why it should retard the breaking down of sodium bicarbonate to carbonate to hydroxide is not known.

The boiler water after silica removal had a more favorable ratio of sodium alkalinity to silica than was experienced before,

which should aid in keeping the silica in solution as sodium silicate and, as nearly as could be determined from analysis of make-up and boiler water, all of the silica entering remained in solution. But the possible effect of ferric oxide was viewed with some fear; however, when the boiler was taken off the line in May, 1946, it was found to be in perfect condition internally. There was a thin coating of greenish slime over the inner surface of the tubes, about $^1/_{32}$ in. thick, but so soft that it washed off completely with a stream of water from a hose. When it dried out the deposit was so soft that it fell off of the tubes and could be crumbled easily in the fingers. It was not necessary to turbine the tubes.

If this process is to be used to treat other waters, it is of course desirable to know something about the quantitative aspects of the reactions involved. Several methods have been used to obtain such data. During one of the rare periods of temporary success early in the work at Alamosa, a sample of sludge showed iron 25.5 per cent and silica 23.5 per cent. The effluent at that time showed 1.5 grains per gal of silica. Thus one pound of iron converted to the hydrous oxide removed nearly a pound of silica.

Hydrodynamic Research

THE Experimental Towing Tank Laboratory of Stevens Institute of Technology, Hoboken, N. J., has developed in ten years from a staff of two men testing sailing-vessel models in the college swimming pool, to a staff of 60 carrying on long-range hydrodynamic research and model tests of Army, Navy, and civilian craft in three of the most modern towing tanks in the country.

The development of the laboratory during these years and its plans for an increased research and training program and for co-ordination of hydrodynamic research throughout the country are outlined in a ten-year report now being published by the Towing Tank Laboratory. In the period of the report 626 projects involving model tests have been completed.

Dr. Kenneth S. M. Davidson, member A.S.M.E., director of the laboratory, said that the tank laboratory is looking forward to a period of intense activity in research during the next ten years. Toward this end, fellowships for graduates of engineering and scientific schools have been established. Two have already been granted and three more are still open.

Plans are being made for a broad course in hydrodynamics, unique in this country, as a joint undertaking of several institutions in the New York area. Recognizing the lack of coordination among the various hydrodynamic laboratories in this country, the Stevens tank laboratory proposes that a group of technical leaders in the various phases of hydrodynamics be formed as an integral part of federal research programs now under consideration.

The report states that ships have been built and sailed for thousands of years, yet today there are many hydrodynamic problems concerning which there is little knowledge. Frequently methods available to ship designers when laying down a design with certain desired characteristics are inexact and in some cases purely folklore.

The aftermath of the war has left many unfinished problems of a long-range nature, such as studies on turning and steering of ships, and the possible advent of atomic-powered ships means overhauling the whole problem of resistance and hull form, the report states. There is also need for the correlation and completion of data on seaplane hulls. With the increase in size and speed of aircraft some of the disadvantages of seaplanes as compared with land planes disappear. Water offers an indestructible and inexpensive landing field available in most parts of the world.

New projects in progress at the present time at the laboratory are investigations for the Navy of the dynamic characteristics of submarines and torpedoes while submerged.

Electronic Stop Watch

AN electronic "stop watch" capable of measuring time intervals as brief as one thousandth of one millionth of a second—so short an interval, that light, speeding at 186,000 miles per sec, would travel only one foot during the measured period—has been perfected in the Sloane Physics Laboratory at Yale University.

It is reported that the stop watch, known as a precision time measurer, is the only machine of its type known to have been developed in this country.

Designed to measure the speed of atomic particles—and to count them as well—the device is also used to determine the energy of a charged particle in nuclear reactions.

The stop watch, a refinement of the measuring techniques used in wartime radar, permits measurement of the energies of the nuclear particles released during changes within the core of the atom. It also has proved of considerable aid in measuring the extremely short lifetime of many atomic nuclei which disintegrate immediately at their formation.

The new device is constructed of conventional radio vacuum tubes and other standard electrical equipment. Its operation depends upon the synchronization of electrical counters which detect an electrical pulse in the circuit. The timing is accomplished by measuring the amount of delay inserted in the circuit in order to synchronize the counters.

The development of the time measurer was sponsored by the Office of Naval Research.

Atomic Emergency Committee

THE recently organized Emergency Committee of Atomic Scientists, of which Albert Einstein is president and Harold C. Urey is vice-president, met on Nov. 17, 1946, in Princeton, N. J., to devise means of raising a $1,000,000 educational fund to aid in enlightening the public on the social implications of nuclear energy, according to the Nov. 29, 1946, issue of *Science*. The committee has announced six objectives of the educational campaign and various members of the committee and others are available to speak on these points in various parts of the country.

The six statements of fact follow: (1) Atomic bombs can now be made cheaply and in large number. They will become more destructive. (2) There is no military defense against atomic bombs and none is to be expected. (3) Other nations can rediscover our secret processes by themselves. (4) Preparedness against atomic war is futile and if attempted, will ruin the structure of our social order. (5) If war breaks out, atomic bombs will be used, and they will surely destroy our civilization. (6) There is no solution to this problem except international control of atomic energy and, ultimately, the elimination of war.

Aside from Professor Einstein and Dr. Urey, the other members of the committee are: Selig Hecht, Columbia University; Victor F. Weisskopf, Massachusetts Institute of Technology; Leo S. Szilard, University of Chicago; Hans A. Bethe, Cornell University; Thorfin R. Hogness, University of Chicago; Philip M. Morse, on leave from Massachusette Institute of Technology; and Linus Pauling, University of California.

Fusion Piercing

A NEW method of making vertical blast holes in hard low-grade iron ore, called fusion piercing, has recently been tested on the Mesabi Iron Range. Increases in drilling speeds of ten times that of older methods have been accomplished.

In fusion piercing, a flame, produced by burning oxygen and a flux-bearing fuel in a special blowpipe, is directed against the surface of the rock or ore. The high flame temperature—about 4000 F—causes some kinds of rock to melt. Pressure of the burning gases forces the molten material past a water spray where it is quenched and broken up. In the quenching process water turns to steam and the steam helps the gases force the quenched material out of the hole. The process of fusion piercing was developed by The Linde Air Products Company, a unit of Union Carbide and Carbon Corporation.

Equipment for commercial use is still in the development stage. For field tests a truck was equipped with a portable oil-field drill rig with the 30-ft special blowpipe replacing the "kelly," and pumps, tanks, motors, and special recording instruments. A more compact and less complicated commercial machine will result when the apparatus that is on the experimental rig solely for the purpose of collecting data is eliminated. It is expected that commercial machines will be operated by a full-time operator and a part-time helper.

Field tests were made on Minnesota "taconite," an extremely hard, tough, abrasive, low-grade iron ore. Six-inch-diameter holes up to 30 ft deep were fusion-pierced at an average rate of 10 ft per hr, with rates as high as 17 ft per hr for short periods. This compares with an average speed of about 1 ft per hr for drilling holes of similar diameter in this ore.

Speed in making blast holes helps reduce mining costs in large-scale operations. In addition, it has been found that the high-temperature piercing flame produces stresses in the surrounding ore which cause better fragmentation during primary blasting, further reducing costs. Those who saw the tests say that fusion piercing will have many advantages in the mining of low-grade ore.

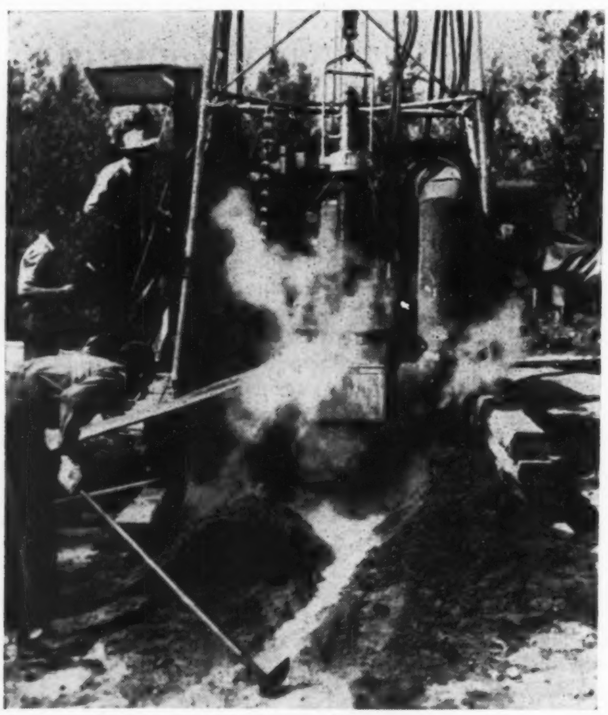


FIG. 5 A TEST RUN UNDER WAY
(The expelled granulated slag can be seen around the hole. The blowpipe is approaching a full depth pierce.)

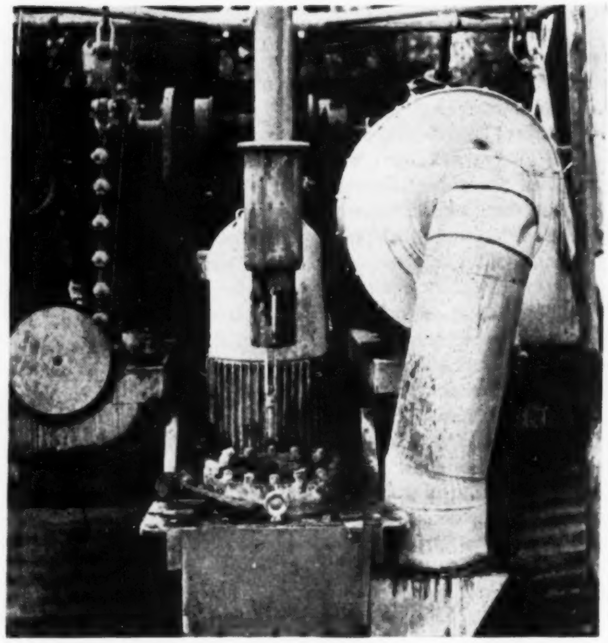


FIG. 6 A VIEW OF THE EXHAUST-GAS COLLECTOR AND THE END OF PIERCING BLOWPIPE

Electronic Crystal Clock

THE demand for time-interval signals accurate to a microsecond in navigation, seismology, and geological surveys, led to the development of an electronic crystal clock by the National Bureau of Standards, according to V. E. Heaton of the Bureau. The crystal clock is now broadcasting second time pulses throughout the world—the only continuous time-signal service provided by any country. One or more of the frequencies broadcast continuously (5, 10, and 15 megacycles per sec and 2.5 megacycles at night) may be received on the usual short-wave radio receiver. These highly accurate time signals which proved of great assistance to the Armed Forces in World War II, are now providing an expanding peacetime service to scientific laboratories, schools, and industry.

The heart of the crystal clock consists of a flawless crystal of quartz with series resonance frequency of approximately 100,000 or 200,000 cycles per sec. By electron-tube circuits the crystal is continuously oscillated and the resulting frequency is divided with no loss of accuracy to 60 cycles per sec. This 60-cycle frequency supplies power to a synchronous motor which, through gear trains, drives contacts that give intervals of 1 min, 5 min, and 30 min to control the automatic announcement equipment of the transmitters. The motor also operates a 1-sec contact which opens an electric gate and allows a highly accurate seconds pulse to be broadcast.

The accuracy of the seconds pulse does not depend on the closing time of the contact. The accuracy is determined by the crystal oscillator frequency which controls a device called a square-wave oscillator and the adjustment of this generator which supplies voltage to an amplifier during alternate $^1/_{200}$-sec intervals. A standard 1000-cycle frequency is fed into the amp-

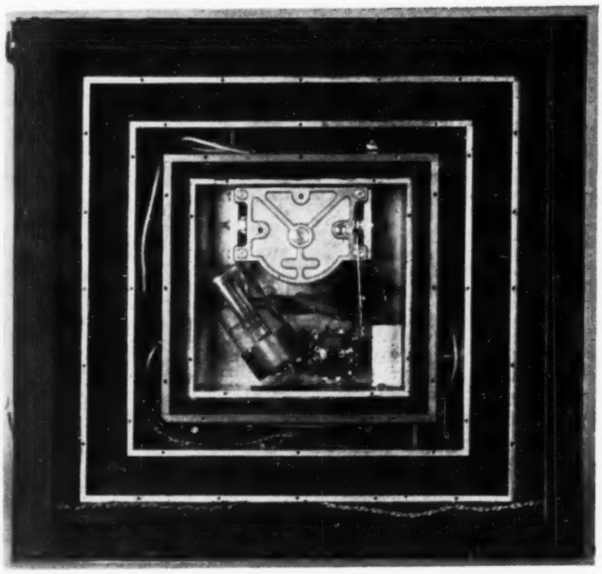


FIG. 7 INTERIOR VIEW OF THE 100-KC STANDARD FREQUENCY OSCILLATOR, WHICH PROVIDES THE CONSTANT FREQUENCY CONTROLLING THE CRYSTAL CLOCK

(Quartz-crystal unit in evacuated container and part of oscillator circuit arrangement are shown in temperature-controlled compartment.)

lifier so that the output consists of groups of five cycles of 1000-cycle frequency spaced $^1/_{200}$ sec apart. During the time when no signal is being passed by the amplifier, the seconds contact is closed and it is opened during the next no-signal period. Therefore the seconds pulse consists of five cycles of 1000-cycle frequency given once each second, supplying a seconds pulse $^1/_{200}$ sec long.

The absolute accuracy of the frequency of the crystal oscillator is at present within a few parts in one hundred million. Although the seconds pulses are obtained by exact division of the quartz-plate frequency, because of possible phase shifts and other difficulties, the pulses are accurate to one part in one million. In other words, the length of a one-second interval as broadcast is accurate to one microsecond. An interval of one minute or longer is accurate to a few parts in one hundred million.

However, to supply an accurate time interval is one thing; to supply a time signal with a high absolute accuracy is quite another. The Bureau depends upon the Naval Observatory to supply the absolute time and differences between this and the time signals broadcast from the Bureau's radio station, WWV, Beltsville, Md. As these differences are based upon data obtained both before and after a radio time signal has been transmitted, it is necessary to extrapolate continually the data from a known correct value two or more weeks in the past. Therefore there are days when the error to the absolute value of the broadcast time may be as great as 0.02 sec.

The quartz crystal of the clock is cut to a certain size and at an angle to the axis of the mother crystal to give the desired frequency and temperature coefficient. Each clock also has a driver-circuit arrangement and frequency-dividing equipment. The rate of the crystal clock depends on the temperature, pressure, and humidity of the air around the quartz plate, and the operating voltage of the circuit supplying the frequency—conditions which necessitate very accurate control. Pressure and humidity are maintained by sealing the quartz plate in a glass or metal enclosure while the temperature is held constant by placing the quartz plate and certain important parts of the circuit arrangement in a constant-temperature oven. See Fig. 7.

There are certain similarities and differences in the crystal clock and the conventional pendulum clock. Each is affected by changes in pressure and temperature; but these conditions may be controlled. The pendulum clock, however, is affected by changes in the gravitational constant to such an extent that changes in water level in the ground, or the tides when the clock is near the seashore, may result in a measurable change in rate. Such changes in gravity produce no noticeable effect on the rate of the crystal clock. It is possible to compare crystal clocks at high frequencies to determine erratic behavior accurately. This has not been done with pendulum clocks.

At the Bureau the equipment used in comparing the various crystal clocks measures accurately in a few seconds a change of rate equivalent to 1 sec in 50 yr. During one month, the change in the rate of drift of a good crystal clock may be less than plus 1 part in one hundred million. Therefore if the clock began the year with correct time and zero rate of drift, it would have gained approximately 2 sec by the end of the year. The short-time variations (10 min or less) are less than one part in one billion.

The broadcasting of time by the National Bureau of Standards came as a by-product of the standard frequency broadcast services which were begun in 1922. Intermittent broadcasts during certain hours of the day became continuous after January, 1941, with station identification at five-minute intervals. The second pulses given as a modulation to the transmitted signal were not announced time signals. However, these pulses did mark time intervals which could be used for the timing of events or for determining the rate of a clock.

Because of the interest of the military forces, the second pulses of the crystal clock were brought into close agreement with the Naval Observatory time signals. In February, 1944, the 59th second pulse was omitted to designate the end of each minute. Announcements of Eastern Standard Time in Continental (International Morse) Code have since been added during the announcement period, which occur each five minutes. These announcements are given during an interruption to the standard audio frequencies which start exactly on the hour.

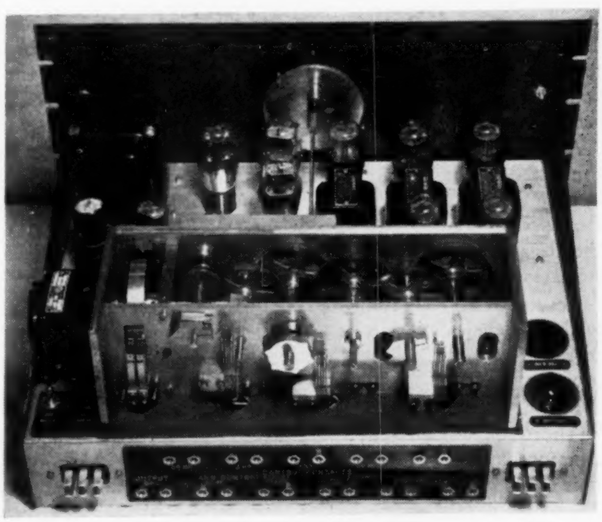


FIG. 8 REAR VIEW OF THE SECONDS PULSE GENERATOR AND TIME-INTERVAL SELECTOR USED IN THE TIME-CONTROL EQUIPMENT OF THE BUREAU'S RADIO STATION

(The 1-sec contact is made by a cam on the flywheel located to the right of the electric motor. The succeeding cams are for the longer time intervals, controlling the announcements for the radio station.)

Solar-Heat Collector

THE effective use of the sun's heat for residential heating has been brought closer to realization as a result of wartime research sponsored by the War Production Board's Office of Production Research and Development, according to a report (PB25375) on sale by the Office of Technical Services, Department of Commerce, Washington 25, D. C. The 154-page report describes the construction and operation of two successful solar-heat collectors which were developed at the Engineering Experiment Station of Colorado, Boulder, Colo.

The heat collector consists of a group of partially blackened, overlapping glass plates, mounted on a house roof. The arrangement is similar to that of shingles, separated by small air spaces. A glass cover over the staggered plates is employed to keep out dirt. By virtue of the high transmissivity of glass for solar radiation, and its low transmissivity for long-wave thermal radiation, the black and clear glass surfaces in the unit become heated when exposed to sunlight, and the reradiated heat has no avenue of escape. Air passing between the plates is heated from the trapped heat of the sun, and forced into the house. Experiments prove that heat can be collected at a higher temperature level by this method than can ordinarily be attained by other types of solar collectors.

The new system has a number of practical advantages. First, it saves fuel. The experimental house installation saved 20 per cent of the fuel that would otherwise have been needed during the test period. It is reported that a more efficient unit currently being designed, could save up to 60 per cent of the fuel requirements. Second, it increases house comfort, particularly in areas requiring only a small amount of winter heating, where most homes have no central heating units. Third, it can create a new industry, with new employment opportunities.

The report describes the first indoor experimental unit, which was heated by tungsten lamps. Results of the preliminary tests are given. The best construction for the unit was found to require a two-thirds overlap of glass plates. Each plate should be blackened for one third of its length on the upper surface; and the plates spaced $^1/_4$ in. apart.

An outdoor experimental unit was built to verify these specifications. A large number of additional variables were also measured and correlated, including solar-heat input, heat collected, efficiency of collection, entrance- and exit-air temperatures, air-flow rate, plate spacing, and various temperatures needed for establishing heat balances.

A third unit was constructed on the roof of a small house and connected to the regular hot-air heating system for a practical test. This collector covered about one third of the entire roof area, occupying the usable surface on the south side of the roof. Electrical connections and automatic controls completed the installation and permitted unattended operation.

Results of all tests indicated that solar heat can be recovered with efficiencies as high as 40 per cent, with exit-air temperatures above 150 F. Higher temperatures can be secured, but at lower efficiencies.

For most efficient home operation, it is stated, ducts should be thoroughly insulated, and a method of storing the heat for a maximum economical period of one day should be developed. It is estimated that a storage bed containing about six tons of dry solids would suffice. If the air were recirculated between the collector and the the storage unit, the storage bed might be appreciably smaller. Experiments on the storage bed are being conducted by investigators at the University of Colorado.

Locations north of the 40th parallel are generally unfavorable for economical solar house heating, the report states. Because of the possibility of using solar-heated air to operate an absorption type of air conditioner, it is felt that the greatest applicability of this system would be in the South.

This solar-heat collector appears to have an efficiency in the same range as that of the flat-plate collectors in which water is heated, and its operation is more efficient and flexible than the method employing large south windows.

Also contained in the report are: A complete tabulation of data and results secured with the laboratory heat collector; a table of fuel savings realized in the solar house; and a table of heat-storage requirements and predicted fuel savings. Diagrams and photographs of the apparatus and graphs of the results also are included. The appendix contains a copy of the development, patent application, details of the calculation methods, and an extensive bibliography.

Plastics Mold Release

A NEW test that has been developed for the evaluation of thermoplastics mold release was revealed by Earl Ziegler, Dow Chemical Company, Midland, Mich., in a paper which he presented before a Rubber and Plastics Division technical session at the 1946 Semi-Annual Meeting of The American Society of Mechanical Engineers held in Detroit, Mich.

Briefly, the test consists of cleaning the metallic test specimen thoroughly, compression-molding the thermoplastic to be tested around the specimen, and then measuring the force necessary to pull the specimen out of the molded plastic.

As a result of the work done with this test, the following conclusions have been reached: (1) Mold surface finish—the most highly polished surface is not necessarily the best for mold release. A fine grind or a matte finish seems superior. (2) Mold metal—metals having a somewhat porous internal structure have better mold-release properties than dense metals. Among the dense metals, stainless steel has the best mold release, chromium plate the worst. The higher the mold metal's coefficient of thermal expansion, the easier a female molding will release. (3) Mold draft angle—apparently, a straight-line function of mold release vs. draft angle exists between zero degrees and five degrees. (4) Mold lubrication—seven lubricants, particularly recommended for use on crystal-clear polystyrene, reduce the pull-out force by as much as 80 per cent. Outstanding for general injection molding are liquid silicons. (5) Molding conditions—changes in molding conditions, which result in decreased internal strain in the molding, improve release noticeably. (6) Addition agents—every colored polymer tested for mold release to date has proved superior to uncolored polymer of the same type. Plasticizers are effective in improving release from rough surfaces. Lubricants within the polymer are much more effective on smooth or polished mold surfaces. (7) Competitive thermoplastics—eight commercially available thermoplastic materials were tested for mold release by the standard procedure for the sole purpose of providing comparative data. The amount or type of coloring agent, plasticizer, lubricant, or filler was not determined. In each case, sound, bubble-free moldings were made around polished chromium-plated test specimens and were tested at constant temperature in the usual manner.

With these conclusions in mind, a four-cavity injection "chip mold" was designed, built, and used to make several thousand moldings. The metal chosen for the mold cavities was porous, sintered iron. It was neither polished nor plated, just left with a matte finish. Draft angles of three degrees were used throughout. No knockout pins were included in the final assembly, only a sprue puller.

Clear polystyrene was tried first in this experimental mold. Given the proper molding pressure, temperature, and cycle,

satisfactory moldings could be made which released nicely. At the same time, operating conditions on the molding machine could be set so as to make all four moldings stick badly.

The use of plasticized and lubricated polystyrene improved mold release noticeably and made it still more difficult for the molding to stick.

Finally, sticking was made virtually impossible by the impregnation of the porous-metal cavities with a good liquid mold lubricant.

This experimental mold proved doubly profitable when it was discovered that the lubricant, absorbed in quantity by the porous metal, actually facilitated the release of a great number of moldings before reapplication was necessary.

Mr. Ziegler's paper was published in full in the September, 1946, issue of *India Rubber World*.

Corrosion Protection

ADVANCES in understanding of corrosion have led to novel protective methods which reduce maintenance and permit operation of equipment under conditions once impossible. The state of the art was summarized by Dr. Herbert H. Uhlig of the M.I.T. Corrosion Laboratory, in a recent joint symposium of the American Chemical Society, the American Institute of Chemical Engineers, and the Electrochemical Society, according to the *Industrial Bulletin* of Arthur D. Little, Inc., December, 1946, from which the following is quoted.

All common metals tend to revert to their ores or to other compounds; metals in which this tendency is weak are said to be more "noble." Nobility, however, is not constant, but depends on environment at any moment and on the materials in contact. On the manipulations of this environment has been built a complex science.

"Cathodic protection," which affords almost complete corrosion prevention, protects many miles of buried iron pipelines and is being considered for protection of hot- and cold-water tanks. It depends on neutralizing the electric currents which flow between minute nonuniformities in the metal surface and cause the metal to dissolve. A direct-current power source, connected at appropriate intervals to the metal, supplies current which may range up to 0.5 amp per sq ft of pipe surface for pipes in an unusually corrosive soil. The metal preferably is painted, so that the required current is less and need protect only possible pinholes in the coating. In a widely used alternative method, buried pieces of zinc or magnesium are connected with the pipe to form a cell. The zinc or magnesium dissolves and must be replaced in perhaps one to ten years. For some metals, corrosion can be reduced by purification, so that opportunities for electrolytic currents do not occur. Impure magnesium will corrode 100 to 500 times faster in sea water than will pure magnesium. This rate is controlled by removing the injurious impurities and adding protective ones.

The use of tin in a tin can or zinc in galvanized iron is revealed as another example of cathodic protection; at any break in the coating, current flows so that the tin or zinc dissolves first. The protection offered varies greatly, however; in sea water the zinc coating of galvanized iron will still prevent rusting of the base, even if there is a break several inches in diameter, while in some drinking waters the base will rust if there is a quarter-inch break. Other coatings, including tin, cadmium, and lead, are protective in some environments and injurious in others. New coatings include aluminum dip-coated on steel. A protective sheet of pure aluminum bonded metallurgically to a stronger but less corrosion-resistant aluminum alloy has been used for some time.

Complex organic corrosion "inhibitors" find increasing use. Minute proportions of a material whose molecule is of the

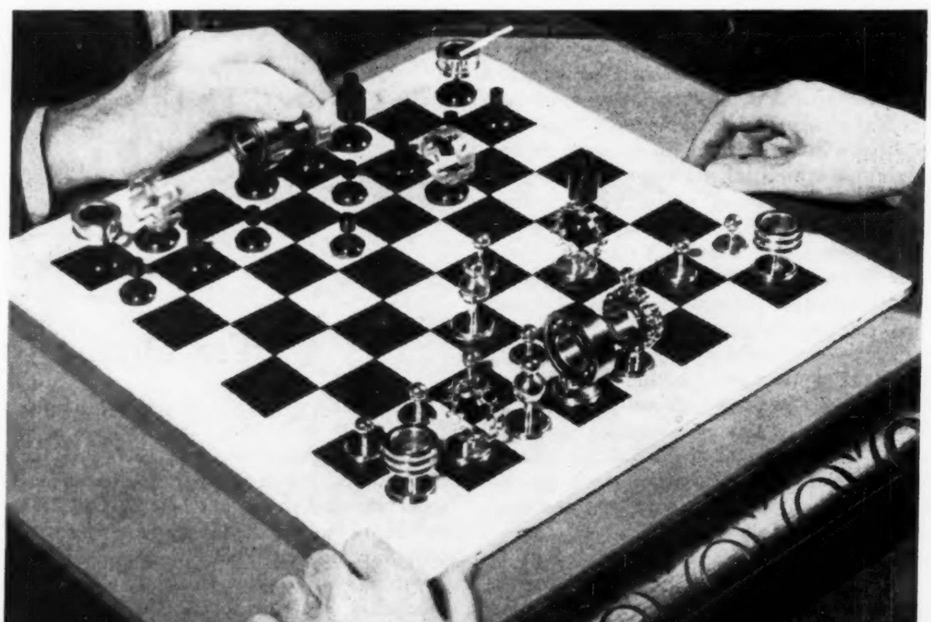


FIG. 9 UNIQUE CHESS SET

(This chess set has been devised by Henry A. Sherwood in co-operation with the SKF ball and roller-bearing firm. The set uses complete bearings for kings; the outer rings are removed to form queens; and bishops, knights, castles, and pawns are made from other bearing parts. Special sets have been presented to President Truman, King Gustav of Sweden, Navy Secretary Forrestal, Air Force General Spaatz and others.)

right size and shape will form a protective layer one molecule in thickness on the surface of a metal. These compounds have been used to protect steel while rust or scale is being removed by acid, to protect oil-well casings while acid treatment is being used to make the surrounding formation more porous and increase oil flow, and in automobile antifreeze solutions. They are being added to lubricating oils and to greases used to protect metal parts from fingerprinting or rusting during handling and shipment. Recently a volatile organic inhibitor has been produced which fills the air space around packaged steel parts and supplies a protective atmosphere.

Some causes of corrosion can be removed, notably in the instance of water for high-pressure steam plants, where dissolved oxygen is removed by heating in specially designed deaerators. Where large volumes of cold water are involved, oxygen content can be reduced in new cold-water deaerators, by spraying the water into a vacuum chamber. Bacteria found in sea water, some soils, and even in deep wells in the Middle West, can so change the environment of a metal as to promote corrosion, enough in one instance for a galvanized-iron cold-water pipe to fail in two years. For protection the bacteria must be killed by treating the water.

Advances are continually being made in development of new corrosion-resistant alloys, particularly for use at high temperatures, as in gas turbines. Here, as elsewhere, progress is based on a new knowledge of the mechanism of protection.

Camera Filter

AN electrically charged camera filter that lets through any single desired wave length or color of light and excludes the thousands of other narrow wave lengths which together produce the sun's white light, was described on Dec. 29, 1946, by its inventor, Dr. Bruce Billings, research physicist, Polaroid Corporation, at a joint meeting of the American Astronomical Society with the American Association for the Advancement of Science held in Cambridge, Mass.

It is reported that the new filter promises to give scientists an opportunity to chart in greater detail the tongues of flaming gas or solar prominences which shoot from the sun. The device may thus hold the key to improved long-range weather forecasting and radio reception which are seriously affected by the radiation and static-producing electrical particles coming from these exploding gases.

High-precision polarizing filters with fixed passbands have been built in the past for photographing the solar prominences. The important new feature of the filter is its ability to change transmission from any one wave length to any other wave length simply at the turn of a dial, without loss of precision or optical quality. For high-speed applications, transmission changes can be made in less than one hundred-thousandth of a second. It is the first camera filter that can be adjusted rapidly and accurately enough to show the infinitesimal differences of color in the exploding solar streamers. "Tuning" is made possible by the use of crystal plates which change their optical characteristics under the influence of electrical charges.

The flaming solar streamers can be photographed only because their light is concentrated in a few specific wave lengths. Although the light from the dense body of the sun is many times more brilliant, it is divided among thousands of wave lengths. When the new filter is aimed at the sun through a coronagraph, a device which produces an artificial eclipse, and tuned to let through the light from the solar streamers, it blocks substantially all the scattered light from the sun's disk. The streamers then photograph clearly against a dark background.

As the luminous gases erupt from the sun in all directions at high velocities, different parts of the gases emit light of slightly different colors. These differences of color are caused by the Doppler effect, the same effect that causes a locomotive whistle to shriek a high note as the train approaches, then fall off to a low note after it passes. Previous filters, fixed at certain wave lengths, could not transmit other wave lengths, thus preventing a completely detailed picture showing how solar streamers travel along the line of sight. Only fragmentary information could be obtained.

With this filter it is said that the astronomer can take a series of pictures as different wave lengths in rapid succession. He can catch every detail of a flaming prominence, despite the color shifts. Such a sequence of detailed photographs taken at known wave lengths will give scientists a complete record of the speed and motion of various parts of a flaming solar tongue. From such records it should be possible to calculate and plot the first detailed "maps" ever made of these explosions.

Tire Testing

BY attaching a section of airplane wing to the side of a test car, the U. S. Rubber Company's tire development department found that it could conduct tire tests at speeds heretofore considered impracticable and unsafe. The airplane wing counterbalances centrifugal force on curves, eliminates side scrubbing of tires, and creates test conditions more like normal highway driving. High speeds not considered safe for testing on public roads can thus be obtained on circular track. In the photo, Fig. 10, the automobile is nearing the camera at 90 mph.

FIG. 10 HIGH-SPEED TIRE TESTING

Tin Dredge

THE world's largest-capacity tin dredge, whose hull measures 246 ft × 76 ft, and features 148 fourteen-cubic-foot buckets, weighing two tons each, was launched on Jan. 6, 1947, by the Tampa Shipbuilding Company at Tampa, Fla. It was christened the "Roosevelt." This dredge is the second of two being built in the United States for the Mining Equipment Corporation, New York, N. Y., a subsidiary of the Billiton Company, The Hague, Holland. Designer and builder of the dredge is Bucyrus-Erie Company, South Milwaukee, Wis. The cost of construction will be more than two million dollars each.

The total building program comprises eight superdredges. When this building program has been completed, tin production in the Netherlands East Indies will be increased to above the prewar level in order to keep pace with the world's increasing demand.

After completion, the Roosevelt will be towed 15,000 miles through the Panama Canal and across the Pacific Ocean, to its destination in the East Indies, by the Moran Towing and Transportation Company, Inc., New York, N. Y. This is believed to be the longest and also the first international towing operation ever undertaken by an American firm.

The Roosevelt will excavate tin bearing sand and gravel to a maximum of 100 ft below water level, raising the ore on a digging ladder 216 ft long and weighing, including tackle, approximately 650 tons.

The endless line of 148 buckets discharges its load at a height equivalent to about five stories above the water line into what is claimed to be the world's largest revolving screen—10 ft in diameter × 70 ft in length. A 150-hp motor drives the screen by means of a 72-in. drive roller.

Tin-bearing concentrates are passed over twenty-four 4-cell jigs for primary concentrates. The dredge has additional jigs for further refining the concentrates through the second and third stages for producing final concentrates which are taken ashore for transportation to the smelter.

After the tin is removed, waste material or tailings are discharged 150 ft astern through sluices from the main jigs. For digging barren overburden a removable chute can be placed in the revolving screen permitting the material to by-pass the treatment plant by means of a chute which discharges 120 ft astern. Distributor and disposal sluices will be lined with a special rubber composition vulcanized to the plates.

Water required for washing and sluicing of ore on the giant dredge is provided by six 12-in. and one 5-in. electrically driven pumps, including stand-by pumps. A total of 1,500,000 gal of water per hr, roughly the volume of water required for industrial and residential use in a United States city of 240,000 population, is the normal requirement of the dredge.

Power for the dredge is supplied by three 875-hp, 8-cylinder, 13-in. × 16-in. supercharged Diesel engines operating at 375 rpm. Each Diesel engine is connected to a 600-kw, 3-phase, 50-cycle, 400-volt, 70-pf, General-Electric generator. The power plant is complete with all required auxiliary equipment and apparatus. Any two of these Diesels operate the dredge while the third is installed for stand-by service. Two 75-kw General-Motors Diesel-generator sets are installed for emergency stand-by and auxiliary service. When digging barren overburden only one Diesel engine and generator is operated.

All dredge operations are handled by electric and hydraulic controls with practically all control equipment automatic so that the operator has very little to do except handle the controls for the various motors. The dredge has all modern safety features. Also furnished are depth indicator, revolution counter, and gage board indicating the operating condition of all units in the tin concentrating plant; bilge alarm system for each water-tight compartment; freeboard alarm for each corner of the dredge; and other modern devices for indicating and recording performance of all major units.

Diesel Laboratory

A COMPLETE German laboratory for Diesel-engine research has been received by the Office of Technical Services, Department of Commerce, Washington 25, D. C. Weighing 68 tons and shipped from Germany in 70 crates, it is reported that the equipment when assembled will comprise one of the most modern Diesel-engine research laboratories yet constructed in the United States.

Diesel engineers who have investigated the German industry for O.T.S., have been unanimous in the opinion that American technicians can learn much from German developments.

The machines, tools, and instruments concerned were taken from the Klockner-Humboldt-Deutsch factory, at Oberusel, Germany, near Stuttgart. They include Diesel engines from one to sixteen cylinders, numerous pulsators, centrifugal test stands, heat-treating furnaces, units of industrial x-ray equipment, impact- and hardness-testing machines, dynamometers, instrument panels, and other testing devices and accessories.

After consultation with representatives of the automotive industry, the U. S. Office of Education, and educational institutions, the laboratory will be set up at a suitable technical school. It is possible that by supplementing the German equipment with other equipment already available, two laboratories may be assembled.

The Diesel laboratory project has been sponsored by the Automotive Advisory Committee consisting of representatives of American automotive firms working in co-operation with O.T.S.

Psychology and Aircraft Design

(Continued from page 141)

able to judge better than I the cost of obtaining a similar degree of improvement in actual performance of this equipment through redesign of the mechanical or electrical components of the sight or computer. This study was carried out by Dr. A. P. Johnson at the Aero Medical Laboratory, and confirmed a similar study of Project AC-94 of the N.D.R.C. Applied Psychology Panel.

SUMMARY AND CONCLUSION

In the first part of this paper was given a preliminary report on a study to obtain from pilots themselves accounts of accidents, near-accidents, and other experiences in which difficulties were encountered in the use of equipment. These experiences cannot be dismissed as happening only to a few stupid individuals. Even the most experienced and skillful pilots admit that they have sometimes made errors of this sort. It is believed that the incidence of such experiences can be reduced by designing new equipment in relation to the psychological capacities and human limitations of the user.

In the second part of the paper was reported a selected group of experiments in the field of psychological engineering. These experiments, unless otherwise indicated, were conducted on sizable groups of A.A.F. pilots.

Experimental designs were used that controlled in so far as possible such factors as learning and previous experience with existing equipment. All findings that have been reported in this paper are based on statistical analysis of experimental data and are significant at the 1 per cent level of probability.

Taken singly these research projects represent a very small contribution to the improvement of aviation equipment. Taken together they represent only the initial attack on a multitude of important problems. It is believed, however, that real progress will come only through systematic scientific study of these problems.

In closing, I should like to paraphrase a statement made earlier this year: If aviation is to achieve its rightful place in peacetime economy, if it is to continue to be the most effective weapon of war, if adequate provisions for safety in flight are to be achieved, if aircraft are to be built so that the average man can fly safely with a minimum of training, then too much emphasis cannot be given to the problem of designing man's most advanced mode of transportation in relation to man's elementary abilities for perceiving and reacting.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Human Factors in Air-Transport Design

Human Factors in Air-Transport Design. By Ross A. McFarland. McGraw-Hill Book Co., Inc., New York, N. Y., 1946. Cloth, 6 × 9¹/₄ in., 670 pp., illus., $6.

Reviewed by Frederick K. Teichmann[1]

The manifold expansion of air transportation, both military and civil, during the last five years has served to increase the attention paid to problems connected with the personal comfort of the crew and passengers. The airplane designer has been familiar, well enough, with the requirements for desirable flight characteristics, power plant, and structure, but he has had little factual data to guide him to meet the requirements which would help in the matter of comfort for the users of air travel.

There are many problems of a psychological and physiological nature that concern the human occupants of the airplane. Many of these need careful study so that at least partial solutions may be incorporated in the design of the structure. Engineers have begun to realize the importance of these problems and welcome any help that psychologists and physiologists can give them. Efforts toward such co-operation have already started in the engineering societies, and setting up a Biomechanics Committee of the Aviation Division of The American Society of Mechanical Engineers is one example.

Engineers who are concerned with designing machines to fit the man should welcome Dr. McFarland's painstaking presentation and correlation and interpretation of voluminous data. No book in recent years has been written in such a way as to meet the engineer on his own grounds, until the present book "Human Factors in Air-Transport Design" was published.

If there should still be someone who is not aware of the complexity of problems affecting air travel comfort, he need only consider the following subjects so excellenty covered in this book: high altitude operation and pressurized cabins; ventilation, temperature, and humidity; control of insects and air-borne diseases; carbon monoxide and other noxious gases; noise and vibration; acceleration, motion and flight performance; passenger accommodations; aircraft accidents; and numerous subdivisions of these broad fields. From 40 to 80 pages, well documented and illustrated, are spent on each of these broad subjects.

Dr. McFarland has not worked in a vacuum. He has consulted and worked with engineers and air-transport operators, and he has studied the source material. He knows whereof he speaks. He does not indicate detailed solutions; that is left up to the design engineer.

[1] Professor and Chairman, Daniel Guggenheim School of Aeronautics, New York University, New York, N. Y. Mem A.S.M.E.

Statistical Quality Control

Statistical Quality Control. By Eugene L. Grant. McGraw-Hill Book Co., Inc., New York, N. Y., 1946. Cloth, 6 × 9 in., 563 pp., charts and tables, $5.

Reviewed by Paul T. Norton, Jr.[2]

The ideas expressed in this timely and important new book will prove useful to all those who are in any way concerned with the quality of manufactured product. The book is a working manual which explains and illustrates how the laws of probability may be utilized to predict and control quality. Statistical techniques are used throughout the book but one does not need to be a statistician to understand these techniques. Much of the book is devoted to a clear discussion of the use of statistical techniques in inspection and in acceptance procedures, but this reviewer feels that the most important single contribution is the explanation of a too little understood fact; that for real economy it is necessary that quality be manufactured into a product, rather than obtained by selecting a satisfactory portion of a product that is made without any real regard to whether the overall quality of the product as made is satisfactory.

The author is peculiarly well equipped to explain these techniques. For many years he has taught a course in engineering applications of statistical methods at Stanford University, and since 1942 he has devoted a large part of his time to conducting courses in the subject in war industries and as adviser in connection with statistical quality control applications in many different types of manufacturing plants. The author was largely responsible for the success of the statistical quality control courses which were held on the West Coast in 1942 under the auspices of the Stanford ESMWT Program, and which lead to the very successful statistical quality control program of the Office of Production Research and Development, War Production Board.

Much of the material in the book is based on the work that has been carried on for more than twenty years by Walter A. Shewhart and others of the Bell System, and which during the years immediately prior to World War II was being used in an increasingly large number of manufacturing plants. On page 3 it is stated that the Shewhart point of view is that: "Measured quality of manufactured product is always subject to a certain amount of variation as a result of chance. Some stable 'system of chance causes' is inherent in any particular scheme of production and inspection. Variation within this stable pattern is inevitable. The reasons for variation outside this stable pattern may be discovered and corrected."

The book is divided into five parts, the headings being as follows:

What Will Statistical Quality Control Do?

The Shewhart Control Chart for Variables.

Other Shewhart Control Charts.

A Statistical Approach to Acceptance Procedures.

Making Statistical Quality Control Work.

It is pointed out that statistical quality control should be viewed as a tool which may influence decisions related to the functions of specification, production and inspection. Its most effective use generally requires co-operation among those responsible for these three different func-

[2] Professor and Head, Department of Industrial Engineering, Virginia Polytechnic Institute, Blacksburg, Virginia. Mem. A.S.M.E.

tions, or decisions at a higher level than any one of them. For this reason, the techniques should be understood at a management level that encompasses all three functions.

Some of the ideas expressed—and proved—will doubtless come as a great shock to most experienced manufacturing executives. For example, that even the most careful 100 per cent inspection will not eliminate all material not conforming to the specifications when the product presented for inspection contains some nonconforming material; that many conventional sampling procedures give very little protection against lots with moderate percentages of defective items and the quality of lots accepted is apt not to be much better than the quality of lots rejected; that, on the other hand, in many cases a properly designed sampling procedure may easily be better than 100 per cent inspection.

The techniques which are described find their most obvious uses in quantity production, but it seems to this reviewer that the author has proved beyond any doubt that an understanding of the fundamental principles underlying the control of quality, as outlined in this book, will be most helpful to every manufacturing executive, no matter how few the number of pieces of any kind which may be involved in his particular case. For example, if it is once understood that variability within certain limits is not only normal but cannot possibly be avoided, one may more readily understand why attempts to improve a process by making changes may often make things worse instead of better. Also that from the viewpoint of real economy due consideration should be given to process limits when setting specification limits. If ideas like these, and others which may be found in various parts of the book, are once thoroughly understood, almost any manufacturing executive can find ways to improve the quality—and economy—of his product, even though he does not use a single one of the specific techniques that are explained.

As stated earlier in this review, the principles outlined in this book can and should be used by every person who is concerned with the quality of manufactured product. This includes top executives, designers, production supervisors, and inspectors. Persons with experience in these lines should be able to adapt the ideas given in the book to all possible conditions, and this task is made easier by the fact that the author has included some 45 worked out examples from many different industries, practically all of which use actual data. There are also many tables and charts, a glossary of symbols used, an excellent bibliography, and what seems to be a very good index.

This book will doubtless find its widest use as a reference book in industry, but it should also prove to be an excellent college textbook. The teacher will be especially glad to note the large number of problems—nearly 150 in all—which are well distributed through the book. It is hoped that many of those who use the book in industry will work many of these problems; this will surely be helpful in obtaining an understanding of the underlying principles of statistical quality control.

Books Received in Library

Naval Machinery, 1946. 2 volumes. United States Naval Academy, Annapolis, Md. Cloth, $8^1/_4 \times 11$ in., paged in sections, illus., diagrams, charts, tables, vol. 1, $4; vol. 2, $4.25. This 2-volume work, presented as a descriptive treatment of steam engines and machinery to be found aboard ships of the Navy, emphasizes construction details and operating principles. The material is grouped into four parts: Parts 1 and 2, naval boilers and naval steam turbines, are in one volume; parts 3 and 4, naval auxiliary machinery and naval reciprocating steam engines, are in the other. The detailed index which appears in both volumes covers all four parts. Twenty-one large, folded plates, relating only to parts 1 and 2 are bound in at the back of that volume, adding to the wealth of illustrative diagrams which accompany the text.

Plastics Handbook for Product Engineers, compiled and edited by J. Sasso. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1946. Cloth, $5^3/_4 \times 9$ in., 468 pp., diagrams, charts, tables, $6. This handbook brings together practical and fundamental data on plastics and synthetic rubber for designers and engineers who want complete facts on the suitability of these materials in new product designs. The book contains specific information on all types of plastics and the properties of each; how to select the right type for a given application; processing, machining, and finishing plastic parts, and on design details such as tolerances, threads, and fastening. Valuable information is given on common faults, causes, and remedies in molded plastic parts. Synthetic rubbers are also covered, from both the chemical and engineering viewpoints.

Tables of Fractional Powers, prepared by the Mathematical Tables Project under the sponsorship of the National Bureau of Standards and the Work Projects Administration for the City of New York and completed with the support of the Office of Scientific Research and Development, L. J. Briggs, Director, and A. N. Lowan. Columbia University Press, New York, N. Y., 1946. Cloth, $7^3/_4 \times 10^3/_4$ in., 486 pp., tables, $7.50. The present volume of this steadily expanding series is a compilation of tables of decimal and fractional powers. In part 1 the values of A^x, for fixed bases and variable exponents, are given to 15 decimal places for two-digit decimals of A and x. In part 2 the function X^a, for variable bases and the frequently occurring exponents $\pm 1/_2$, $\pm 1/_3$, $\pm 2/_3$, $\pm 1/_4$, $\pm 3/_4$, is also tabulated to 15 places. As usual, there is a bibliography of similar tables. In the foreword to the volume various problems are suggested, the solution of which is facilitated by the use of the present tables.

What Is Industrial Engineering? J. D. Woods & Gordon Limited, Industrial Engineers & Consultants, West Toronto, Canada, 1946. Paper, $7 \times 10^1/_4$ in., 74 pp. In a brief, practical manner this book discusses the function of an industrial engineer, which boils down to the study and analysis of a situation as it exists, and the recommendation of procedures for improving the situation under review. This theme is developed under the following headings: business and industrial surveys; selling and marketing analysis; training programs; time and motion study; incentive plans; and personnel work.

What Are Cosmic Rays? By P. Auger, translated from the French by M. M. Shapiro. University of Chicago Press, Chicago, Ill., 1945. Cloth, $5^1/_4 \times 7^3/_4$ in., 128 pp., plates 1-12, $2. This book presents a simple, straightforward account of all the major cosmic-ray phenomena for the reader who lacks a technical knowledge of physics. A translation from the original French, the new edition has been revised in the light of recent new discoveries and important changes in the field of cosmic rays. The history of the development of cosmic-ray research is reviewed in the early chapters, and a number of photographs of tracks of electrified particles are collected at the back.

Wood Patternmaking. By H. J. McCaslin. Fourth edition. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1946. Cloth, $4^3/_4 \times 7^1/_2$ in., 366 pp., illus., diagrams, tables, $2.60. The fundamental principles and practice of wood patternmaking are given, with thorough explanation of molding demands and structural features involved in the making of wood patterns and their auxiliary core boxes. A wide range of modern shop practice is covered, and a list of visual aids—motion pictures and film strips—is correlated with the material in the book.

X Rays in Practice. By W. T. Sproull. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1946. Cloth, $5^3/_4 \times 9$ in., 615 pp., illus., diagrams, charts, tables, $4. The history, fundamentals, and characteristics of x rays and x-ray spectra serve as the introduction to this comprehensive work. With emphasis on the practical aspects, the book proceeds with the generation, absorption, scattering and diffraction of x rays, the measurement and recording of x rays, and descriptions of x-ray equipment. Particular applications dealt with include industrial radiography, medical applications, crystallography, fluoroscopy, microradiography, and numerous minor uses.

Library Services

Engineering Societies Library books may be borrowed by mail by A.S.M.E. members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquires to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

A.S.M.E. BOILER CODE

Proposed Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revisions of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the code, to be included later in the proper place.

The following proposed revisions have been approved for publication as proposed addenda to the code. They are published herewith with corresponding paragraph number to identify their location in the various sections of the code and are submitted for criticism and approval from anyone interested therein.

It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York 18, N. Y., in order that they may be presented to the Committee for consideration.

PARS. L-29 and L-113(**a**). Omit second sentence of Par. L-29 and add the following to Par. L113(**a**):

The welding procedure and welding operator shall have been qualified under the provisions of Section IX of the Code for the material, type of weld, and position in which the welding is to be done.

PAR. U-5. Add the following:

Exclusive of any valves made inoperable by a stop valve as provided in Par. U-2(**a**).

PAR. U-6(**b**). Add the following to the first sentence: "except as provided in Par. U-2(**a**)."

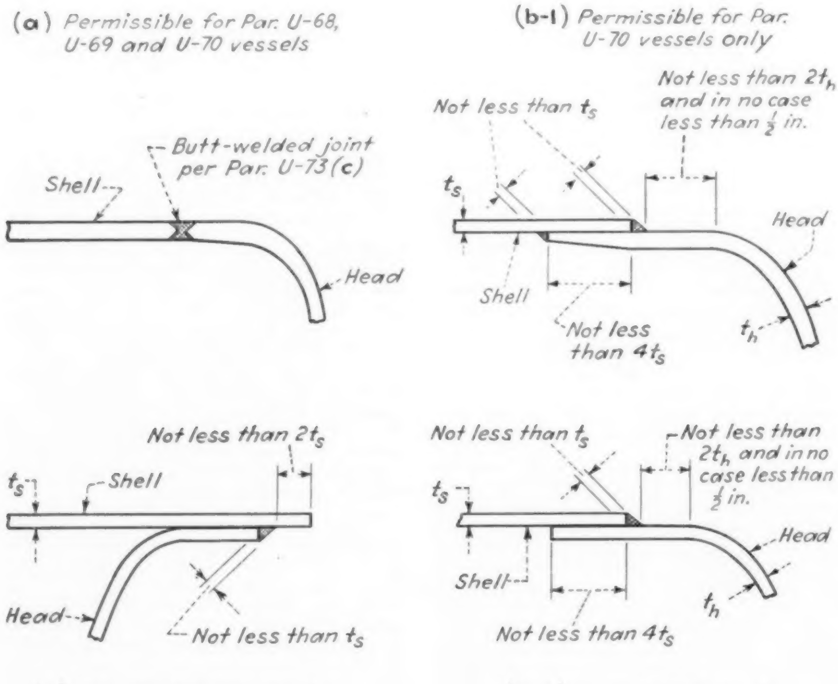


FIG. U-18 REVISED

PAR. U-7. Delete the words: "which is exposed to a temperature of 32 F or less."

PAR. U-73(**c**). Revise the second sentence to read as follows:

Circumferential and other joints of vessels uniting the plates of the shell, or other pressure parts, except as provided for in Par. U-59, covered by Par. U-69 shall be of the double-welded butt type, except that for thicknesses of $5/8$ in. or less they may be of the single-welded butt type and for inserted heads with pressure on the convex side only and maximum allowable working pressure not to exceed 300 psi, they may be as shown in Fig. U-18(**c**).

PAR. U-75. Revise to read:

U-75 **Dished Heads.** When welded as shown in Fig. U-18(**a**) and (**c**), heads dished to a segment of a sphere and dished heads of a semi-ellipsoidal form shall have a skirt (flange) not less than $1^1/_2$ in. long, except when the nominal head thickness is $1/2$ in. or less, in which case the skirt (flange) length shall be not less than 3 times the thickness of the head.

When welded as shown in Fig. U-18(**b**), for vessels covered by Par. U-70, the length of skirt (flange) shall be at least sufficient to meet the requirements of that figure.

When heads are inserted into the shell, it shall be with a driving fit and welded as shown in Fig. U-18.

Full-hemispherical heads need not have an integral skirt (flange) but when a skirt (flange) is provided for butt-welded attachment it shall have at least the thickness required for an equivalent seamless shell.

PAR. P-200. Add the following as (**c**), lettering the present sections as (**a**) and (**b**):

(**c**) Fusion welding may be used in lieu of threading or riveting for the attachment of stays to plates in accordance with the following requirements:

(1) The stays shall be inserted into holes through the sheet, except as provided in (5), and the area of the weld in shear shall be not less than 1.25 times the required cross-sectional area of the stay, but in no case shall the size of the weld be less than $3/8$ in.;

(2) The face of the weld shall not be below the outside surface of the plate.;

(3) The ends of stays inserted through the sheet shall not project more than $3/8$ in. beyond surfaces exposed to products of combustion;

(4) When flat heads are supported by diagonal stays protruding through the shell, the cross-sectional area of the portion of the stay extending through the shell shall be not less than 1.25 times the required cross-sectional area of the stay;

(5) Diagonal stays may be attached to the inner surface of the shell, but not the head, by fillet welds only, provided:

(*a*) The size of the welds is not less than $3/8$ in.;

(*b*) The cross-sectional area of the portion of the stay welded to the shell and also the cross-sectional area of the fillet welds parallel to the axis of the shell, measured at the throat,

are not less than 1.25 times the required cross-sectional area of the stay, and further provided that such fillet welds shall continue the full length of the side of the stay.

(6) The longitudinal centerline of the stay (projected if necessary) shall intersect the inner surface of the plate to which the stay is attached within the outer boundaries of the attaching welds (also projected if necessary);

(7) The pitch of stays attached by welding to flat surfaces shall comply with all rules in this Code applicable to threaded or riveted stays;

(8) The material for stays shall comply with Specification SA-31 and the material for plate shall comply with Specifications SA-30, SA-70, SA-89, SA-201, or SA-212;

(9) The welding procedure and welding operators shall be qualified in accordance with Section IX of the Code;

(10) The welding shall be done in such a manner that excessive weld deposits do not project through the surface of the plate at the root of the weld;

(11) The welding shall be stress-relieved in accordance with Par. P-108.

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code may communicate with the Committee Secretary, 29 West 39th St., New York 18, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of Dec. 7, 1946, and approved by the Council on January 9, 1947.

CASE No. 1035

(*Interpretation of Figs. P-2 and U-15*)

Inquiry: Is it permissible to flame cut the edges of the straight portions of the reduced-section tension specimen shown in Figs. P-2 and U-15 of the Code in the same manner as is shown in Fig. Q-6 of Section IX of the Code?

Reply: It is the opinion of the Committee that when Fig. Q-6 was adopted, Figs. P-2 and U-15 should have been revised to correspond thereto. In view of this it is permissible to prepare the reduced-section tension specimen shown in Figs. P-2 and U-15 by flame cutting and then machining for the reduced-section portion of the specimen in the same manner as shown in Fig. Q-6.

CASE No. 1036

(*Interpretation of Specification SA-83*)

Inquiry: Is it permissible to use tubing complying with A.S.T.M. Specifications A 179-44 as a substitute for Specification SA-83 for use as boiler tubing?

Reply: It is the opinion of the Committee that material complying with A.S.T.M. Specifications A 179-44 or A 179-46 may be used as a substitute for material complying with Specification SA-83, under the note appearing in Specification SA-83.

CASE No. 1037

(*Special Ruling*)

Inquiry: (*a*) May corrosion-resistant steel sheet or plate be used in constructing cylindrical combustion chambers welded into low-pressure steel heating boilers and if so, how shall the minimum thickness of such combustion chambers be calculated?

(*b*) May corrosion-resistant steel fire tubes be used in low-pressure heating boilers and if so, how shall the minimum thickness be calculated?

Reply: (*a*) Cylindrical combustion chambers 5 in. to 18 in. in diameter in low-pressure steel heating boilers may be made from corrosion-resistant steel under the following rules:

(1) The material shall comply with Specification SA-240, Grade S,M,T, or C;

(2) The welding of the combustion chamber and its installation into the boiler shall be done under a procedure and by welding operators qualified according to Section IX of the Code;

(3) The thickness of the material shall be calculated according to Par. P-241 of the Code, but in no case shall it be thinner than $\frac{1}{8}$ in.;

(4) The maximum out-of-roundness of the cylinder shall be as specified in Par. U-125 of the Code.

(*b*) The fire tubes in low-pressure heating boilers may be made from corrosion-resistant steel under the following rules:

(1) The material shall be a Code material and the tubes shall be manufactured by a process recognized by Code specifications;

(2) The thickness of the material shall be calculated according to the formula in Table P-4 of the Code but in no case less than 2 gage thicknesses below the minimum specified for steel tubes in Table H-3 of the Code;

(3) Tubes may be installed by rolling and flaring or by welding. If by welding the operation shall be done under a procedure and by a welding operator qualified under Section IX of the Code.

CASE No. 1038

(*Special Ruling*)

Inquiry: For dished heads convex to the pressure as shown in Fig. U-18(*c*), Par. U-73(*c*) indicates that this construction is permissible on vessels covered by Par. U-70, since the head joint may be regarded as of the lap type. Is this construction also permissible for pressure vessels covered by Par. U-69?

For dished heads concave to the pressure, as shown in Fig. U-18(*a*), and convex to the pressure, as shown in Fig. U-18(*c*), the minimum permissible length of head flange required by Par. U-75 is difficult to provide in thin heads of relatively small diameter. Is it permissible to use shorter lengths of flange (skirt) in dished heads concave to the pressure as shown in Fig. U-18(*a*), and convex to the pressure as shown in Fig. U-18(*c*) than now required by Par. U-75?

Reply: It is the opinion of the Committee that the existing provisions may be modified and vessels stamped with the symbol if the following rules are observed:

(1) The construction shown in Fig. U-18(*c*) may be used for pressure vessels under Par. U-69 provided the pressure is on the convex side only and the maximum allowable working pressure does not exceed 300 psi. The throat of the fillet weld shall be not less than the thickness of the shell.

(2) For the construction shown in Fig. U-18(*a*) and (*c*), the heads shall have a skirt (flange) not less than $1\frac{1}{2}$ in. long, except when the nominal head thickness is $\frac{1}{2}$ in. or less, in which case the skirt (flange) shall be not less than 3 times the thickness of the head.

Attention is called to the construction of Fig. U-18(*b*), where the length of skirt (flange) is governed by the requirements of that figure plus the requirement in Par. U-73(a) that the surface overlap for a lap type joint shall be at least 4 times the thickness.

A.S.M.E. NEWS

And Notes on Other Engineering Societies

Industrial Development of Southwest Theme of A.S.M.E. 1947 Spring Meeting at Tulsa, Okla., March 2 to 5

ONCE again The American Society of Mechanical Engineers has the good fortune to hold its regular Spring Meeting in one of the great industrial cities of the South. This year, with recollections of Chattanooga, Tenn., still fresh, the Society looks with pleasure to the A.S.M.E. 1947 Spring Meeting to be held in the Mayo Hotel, Tulsa, Okla., March 2 to 5, 1947, when the program will focus attention on the industrial development of the Southwest.

Although a young city as cities go, Tulsa has long had the distinction of being one of the oil capitals of the world. Within its metropolitan area there are more than 450 oil-producing, refining, marketing, transportation, drilling, and supply companies, in addition to 482 peacetime factories, 300 of which were fully or partially engaged in production of wartime materials during the war. These plants have continued to produce and the city's wartime employment and population have shown no decline.

Tulsa's $15,000,000 public-school system has attracted national recognition. The University of Tulsa, Oklahoma's only fully accredited privately endowed university, is well known for its College of Petroleum Engineering.

Crowning the heights of Woodward Park is the Tulsa Rose Garden, a project originated more than 10 years ago by the Tulsa Rose Club in conjunction with the city park commission.

In a program composed of technical sessions, dinners, luncheons, and inspection trips to industrial plants and cultural institutions, A.S.M.E. members and guests will hear discussed not only the industrial development close to the interests of the host city, but new ideas in the current evolution in engineering education and advances in the art of mechanical engineering.

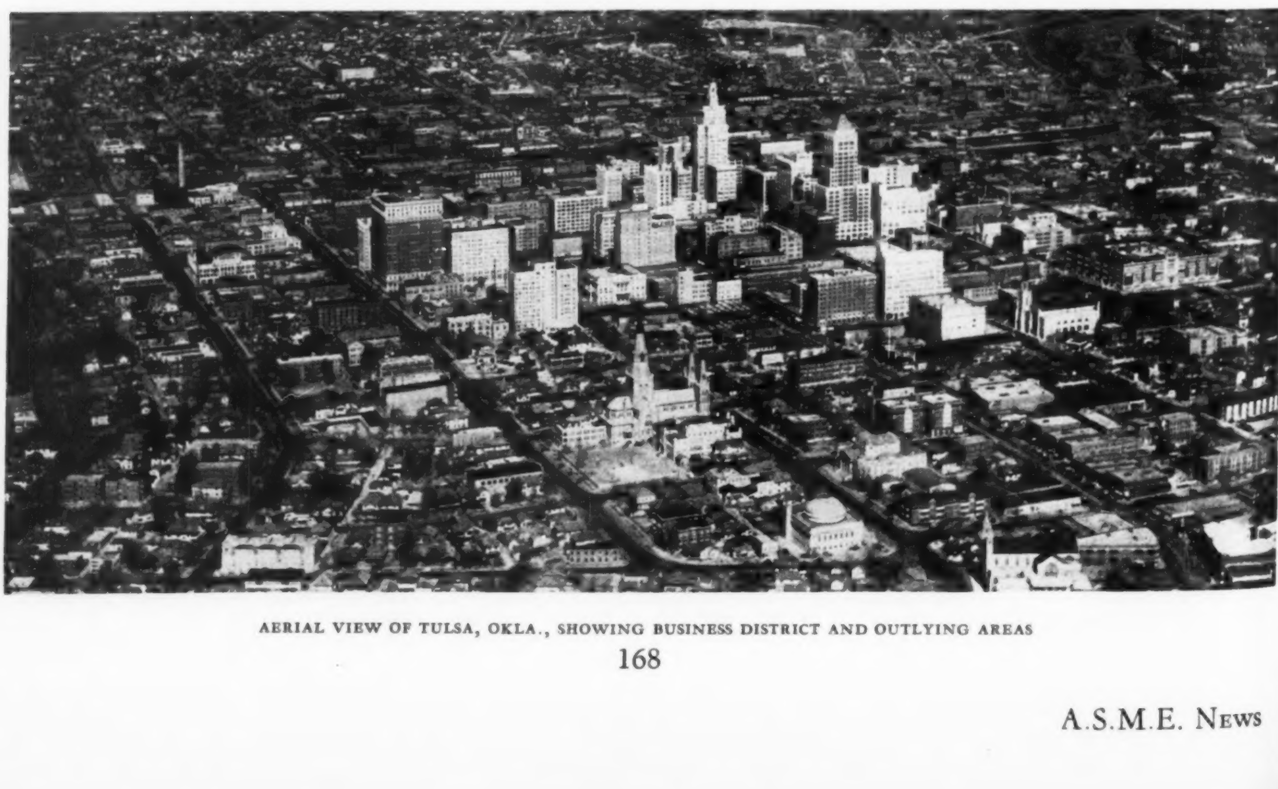
Technical sessions have been planned by the following professional divisions: Applied mechanics, aviation, fuels, heat transfer, industrial instruments and regulators, management, metals engineering, oil and gas power, and power. Sessions will also be sponsored by the Petroleum Committee of the Process Industries Division and the Committee on Education and Training.

The keynote luncheon will be held at the Tulsa Engineers' Club, at which the mayor of Tulsa will extend an official welcome.

Eugene W. O'Brien, President A.S.M.E., will speak on the subject: "Opportunities Lie About You."

Tuesday afternoon will be given over to inspection trips to the Franks Manufacturing Company, where the fabrication of portable drilling rigs will be observed, and to the Macnick Manufacturing Company, manufacturers of precision products. An inspection trip to the Spartan School of Aeronautics is also planned.

On Sunday trips are planned to interesting points in Tulsa and to the Will Rogers Memorial at Claremore, Okla., a distance of 30 miles from Tulsa, where a large collection of



AERIAL VIEW OF TULSA, OKLA., SHOWING BUSINESS DISTRICT AND OUTLYING AREAS

memorabilia of the late Will Rogers, recipient of the A.S.M.E. Spirit of St. Louis Medal, 1935, is kept. There, such things as saddles, guns, and many other items of the early country will be seen.

Make Hotel Reservations Early

Because the Mayo Hotel, A.S.M.E. headquarters for the Spring Meeting ,was not able to guarantee a definite number of rooms to members, it is suggested that members make reservations at once, stating their requirements, date, and time of arrival. There are a number of good hotels in Tulsa. These should be able to meet all requests for accommodations.

Hotel rates in Tulsa, Okla., range from $2.25 to $6.25 for single rooms; $3.75 to $7.00 for double rooms with double bed; and $4.25 to $8.50 for double rooms with single beds.

Should the hotel fail to confirm a request for accommodations, members are asked to write to Willard E. Bauman, chairman, Hotel Committee, Box 661, Tulsa, Okla., who will arrange satisfactory accommodations.

Committee

The General Arrangements Committee of the Spring Meeting is headed by W. Fred Stewart. Other members are as follows: treasurer, Carl Stevens; registration, Clarence Glasgow; hotel arrangements, W. E. Bauman; technical sessions arrangements, F. J. Daasch, chairman, C. H. Blue, W. B. McDermott, and W. C. Moody; finance, Orval Lewis; publicity, Jim Wilson and R. B. Tuttle; social and ladies' entertainment, Mr. and Mrs. G. McConnell; entertainment, A. J. Hanssen; plant trips, R. A. Colgin, chairman; welcome committee, L. T. Gibbs, chairman, D. Cant, John Keyes, and D. O. Johnson.

Tentative Program

The tentative program follows:

SUNDAY, MARCH 2

1:30 p.m.

Sight-seeing—Will Rogers Memorial and the City of Tulsa, Okla.

2:00 p.m. Registration

MONDAY, MARCH 3

8:00 a.m.

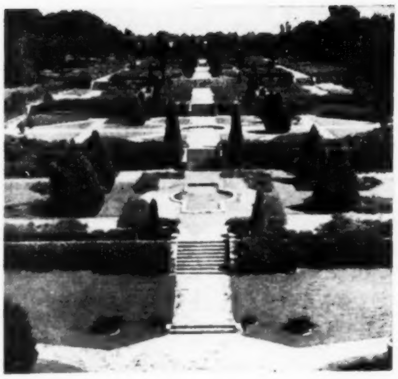
Registration

9:00 a.m.

Power (I)

A Method for Testing and Studying the Cost of Operation of Centrifugal Boiler Feed Pumps, by A. C. Pasini, technical engineer, The Detroit Edison Company, Detroit, Mich., E. M. Spencer and J. R. Hamann, junior engineers, The Detroit Edison Company, Detroit, Mich.

Fatigue Tests of Welding Elbows and Comparable Double-Mitre Bends, by A. R. C. Markl, chief research engineer, Tube Turns, Inc., Louisville, Ky.



THE TULSA ROSE GARDEN, TULSA, OKLA.

12:00 noon

Keynote Luncheon

Jointly with the Tulsa Engineers' Club. Toastmaster: H. M. Cooley, president, Tulsa Engineers' Club, Tulsa, Okla. Welcome: Hon. Lee Price, Mayor, Tulsa, Okla. Speaker: Eugene W. O'Brien, president, A.S.M.E. Subject: Opportunities Lie About You.

2:30 pm.

Aviation

Propeller-Drive Gas Turbines, by Alan Howard, turbine engineering department and C. J. Walker, development engineer, both of General Electric Company, Schenectady, N. Y.

Gas-Turbine Combustion, by E. P. Walsh, design engineer, aviation gas turbine division, W. D. Pouchot, both of Westinghouse Electric Corporation, Philadelphia, Pa.

Power (II)

Operating Experience With Heat Pumps, by Philip Sporn, vice-president, American Gas and Electric Service Corporation, New York, N. Y.

Steam-Jet Refrigeration for Turbogenerator Air, Gas, and Oil Coolers, by P. H. Knowlton, assistant design engineer, turbine-generator division, General Electric Company, Schenectady, N. Y.

8:00 p.m.

Power (III)

Symposium on Outdoor Steam Stations, by A. R. Smith, managing engineer, turbine generator division, General Electric Company, Schenectady, N. Y.

Refiner's Viewpoint of Electric Power Use, by W. H. Stueve, commercial and industrial agent, Oklahoma Gas and Electric Company, Oklahoma City, Okla.

Oil and Gas Power

Oil Filter Testing, by W. J. Ewbank, chief research engineer, The Briggs Filtration Company, Bethesda, Md.

Turbines for Natural Gas Expansion, by Stephen Bencze, steam turbine development engineer, Elliott Company, Jeannette, Pa.

Management (I)

Motion and Time Study Application to Petroleum Production, by H. G. Thuesen, professor of industrial engineering, Oklahoma Agricultural and Mechanical College, Stillwater, Okla.

TUESDAY, MARCH 4

9:00 a.m.

Fuels

Combustion of Coke Deposit on a Synthetic Bead Cracking Catalyst, by W. A. Hagerbaumer and Russell Lee, Socony-Vacuum Oil Company

The Fuel Industry in Japan, by W. T. Reid, Battelle Memorial Institute, Columbus, Ohio

Education

Subject: Unified Curriculum. Speakers to be announced.

Industrial Instruments and Regulators

Deep-Well Camera, by O. E. Barstow, Dow Chemical Company, Midland, Mich., and C. M. Bryant, Dowell, Inc., Tulsa, Okla.

Apparatus for Analysis of Reservoir Fluids, by Paul G. Exline, section chief, and H. J. En Dean, both of Gulf Research and Development Company, Pittsburgh, Pa.

2:00 p.m.

Plant Trips

Franks Manufacturing Corporation, Tulsa, Okla. (Portable Drilling Rigs)

Spartan School of Aeronautics and Airplane Overhaul and Repair Station, Tulsa, Okla.

Macnick Manufacturing Company, Tulsa, Okla.

6:00 p.m.

Banquet

Toastmaster: Alfred E. Ballin, Balco Engineering Company, Tulsa, Okla. Subject:

Registration Fee for Non-Members at the 1947 Spring Meeting

There will be a registration fee of $2 for non-members attending the 1947 Spring Meeting. For non-members wishing to attend just one session (except evening sessions or meal meetings) the fee will be $1. This is in accordance with the ruling of the Standing Committee on Meetings and Program.

Members wishing to bring non-member guests (male) may avoid this fee by writing to the Secretary of the Society before February 15 asking for a guest-attendance card for the Spring Meeting. The card, upon presentation by a guest, will be accepted in lieu of the registration fee. Guests are limited to *two per member*.

Engineering in the Future Southwest. Program: Indian Music and Dances, by Bat Shunatora and Indian Aides.

WEDNESDAY, MARCH 5

9:00 a.m.

Management (II)

Selection, Training, and Management of Sales Force, by A. F. Lyster, manager, industrial dept., Socony-Vacuum Oil Company, Kansas City, Mo.

Petroleum (I)

Engineering Details of Off-Shore Drilling Operations, by R. G. Watts, Magnolia Petroleum Company, Dallas, Texas.

The Fisher-Probst Process, by George Roberts, Stanolind Laboratory, Tulsa, Okla.

12:30 p.m.

Management Luncheon

Toastmaster: Lloyd T. Gibbs, L. T. Gibbs Company, Tulsa, Okla.

Subject: Management's Participation in Enacting Legislation to Protect Industry's Interest. Speaker to be announced.

2:30 p.m.

Metals Engineering

Low-Temperature Impact Properties of Some Cast Steels, by H. D. Churchill, Case School of Applied Science, Cleveland, Ohio

Conventional Straightening of Welded and Seamless Tube Stock as Practiced in the Industries, by E. W. Wrage, Globe Steel Tubes Company, Milwaukee, Wis.

Fabrication Notes on Corrosion-Resistant Alloys, by J. C. Holmberg, metallurgist, Tulsa Boiler and Machinery Company, Tulsa, Okla.

Petroleum (II)

Hydraulic Pumping Units, by R. M. Stuntz, Gulf Oil Corporation, Tulsa, Okla.

A.S.M.E. Plans Tour of National Parks

THE happy custom of organizing vacation tours in connection with national meetings of the Society will be resumed on a somewhat restricted scale with the A.S.M.E. 1947 Fall Meeting scheduled for Sept. 1 to 5, 1947, in Salt Lake City, Utah.

Because of a limitation set by hotels and railroads, the A.S.M.E. group will be limited to 150 members and guests. They will leave New York on Aug. 13 for Chicago, Ill., then continue on to Lake Louise, Glacier National Park, Teton National Park, and Zion National Park, and arrive at Salt Lake City in time for the Fall Meeting. The return trip to New York will be through the Rocky Mountain National Park and Chicago.

Approximate cost of the tour will be $750 per person. This price includes hotel accommodations, meals, (except during the Fall Meeting) and handling of baggage.

Members interested in making the tour are urged to make reservations early.

E.J.C. Considers Various Professional Problems at December Meeting

Favors Action on World Organization

OUT of the wealth of professional engineering experience represented by the presidents, junior past-presidents, and secretaries of the four Founder Societies and the American Institute of Chemical Engineers, who assemble quarterly around the meeting table of the Engineers Joint Council, come many ideas which aim to advance the interests of the engineering profession on many fronts.

A world organization of engineers and a new labor-legislation panel to present the engineering point of view to legislatures, were some of the ideas discussed at the Dec. 5, 1946, meeting of the Engineers Joint Council in the Engineering Societies Building, New York, N. Y. The meeting, attended for the first time by Eugene W. O'Brien, newly elected president A.S.M.E., convened in the morning and continued until late in the afternoon; and when it adjourned many items on the agenda had to be carried over to the next meeting on Feb. 21, 1947.

A report of statements made by Col. J. A. Frank of the United States Department of State was one of the first matters of business taken up. Colonel Frank had commented favorably on the value to the Departments of State, War, and Navy of the E.J.C. reports on industrial disarmament of Germany and Japan, and on the desirability of having E.J.C. representation on the State Department's National Committee to UNESCO. He had conveyed the thanks of several federal bureaus to whom the E.J.C. had given co-operation. Colonel Frank had spoken as a guest of several engineers at a luncheon meeting in New York, N. Y., on Dec. 3, 1946.

World Engineering Conference

The E.J.C. through its Committee on International Relations, sponsored a Committee on American Participation in the International Technical Congress held in Paris, September, 1946. This committee offered a well-balanced presentation of the American point of view on professional engineering matters before the Congress. It organized transportation to and from Paris and took care of the routine details involved in such a co-operative effort.

When European delegates at the conference proposed organization of a continuing world organization of the engineering profession, the Committee assumed responsibility of speaking for American engineers. They were helpful in guiding the deliberations and, primarily upon their advice, a loose continuing organization called the World Engineering Conference was set up instead of a more elaborate world federation of engineers.

A detailed account of the formation of the Conference and the opportunities which the new world agency makes available to American engineers is covered in the article, "The American Stake in World Engineering," by Fenton B. Turck, member E.J.C. Committee on International Relations. The article is published on pages 142 to 144 of this issue.

In a report of American participation in the Congress in Paris, it was shown Americans have an opportunity to assume world leadership of engineers.

The E.J.C. voted to request constituent societies to authorize limited participation in and co-operation with the World Engineering Conference by the formation of a National Commission under the Committee on International Relations to which all competent engineering bodies in the United States with an interest in international affairs would be invited to participate by naming representatives to the National Commission. An appropriation of $5000 is being considered to cover these activities.

Labor-Legislation Panel

The E.J.C. approved three fundamental principles on employee relations, and created a panel composed of one representative from each of the respective societies to bring these principles to the attention of legislators working on new legislation. The principles follow:

(1) Any group of professional employees who have a community of interest and who wish to bargain collectively should be guaranteed the right to form and administer their own bargaining unit and be permitted free choice of their representatives to negotiate with their employer.

(2) No professional employee or group of employees, desiring to undertake collective bargaining with an employer, should be forced to affiliate with or accept membership in any bargaining unit which includes nonprofessional employees or to submit to representation of such group or its designated agents.

(3) No professional employee should be forced against his desire to join any bargaining unit or other organization as a condition to his employment, or to sacrifice his right to individual personal relations with his employer in the matter of employment conditions.

Walter S. Finlay, Jr., fellow A.S.M.E., vice-president, J. G. White Engineering Corporation, New York, N. Y., has been named the A.S.M.E. representative on the E.J.C. New Labor Legislation panel.

To give the panel broader representation, the E.J.C. voted to invite the American Society for Engineering Education and the National Society of Professional Engineers to appoint representatives to this panel.

Economic Survey

I. Melville Stein, member A.S.M.E., chairman, E.J.C. Committee on Economic Status of the Engineer, reported that of 85,000 questionnaires sent to members of constituent societies in co-operation with the Department of Labor, 63 per cent had been returned by the Nov. 15 dead line, and that the analysis cards were being cut and run through the Bureau's machines. Andrew Fraser, a consultant retained by the E.J.C. to analyze the returns, is ex-

pected to report soon on some phases of the analysis. The Council voted to publish partial results as soon as they become available.

Mr. Stein also reported that the National Roster of Scientific and Specialized Personnel were using a similar questionnaire and that eventually information will become available on the economic status of most American engineers.

National Security

The E.J.C. recommended that a standard questionnaire be sent to members of the constituent societies to determine the use made of engineering skills during World War II. The American Chemical Society has already conducted such a survey and one is under way by the American Institute of Physics.

A. W. K. Billings Honored by A.S.C.E.

HONORARY membership in the American Society of Civil Engineers was conferred on A. W. K. Billings, member A.S.M.E., retired president, Brazilian Traction, Light and Power Company, and officer of many other Brazilian electric-power companies, during the 94th annual meeting of the A.S.C.E. at the Hotel Commodore, New York, N. Y., Jan. 15-17, 1947.

Mr. Billings, who is an international authority on electric street railways, and hydroelectric plants, was recently awarded the highest nonmilitary decoration of the Brazilian Government, the National Order of the Southern Cross, in recognition of his work in the development of the hydroelectric resources of the São Paulo-Rio de Janeiro area.

By damming up and reversing the flow of the streams in this area, Mr. Billings was able to take advantage of a 2000-ft drop from the mountainous plateau to the coastal plain. The cheap power provided in this manner aided industrialization of the area, while the dams of the project helped to ease flood-control problems.

S.A.E. Elects Officers

ELECTION of C. E. Frudden, tractor division, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., as the 1947 president of the Society of Automotive Engineers was announced at the S.A.E. 1947 annual meeting in Book-Cadillac Hotel, Detroit, Mich., Jan. 7, 1947. President-elect Frudden succeeds L. Ray Buckendale, Timken-Detroit Axle Company, Detroit, Mich., who served for 1946.

The following vice-presidents were also elected: air transport, Harold R. Harris, American Overseas Airlines, Inc., New York, N. Y.; aircraft, James M. Shoemaker, of United Aircraft Corporation, Stratford, Conn.; aircraft power plant, Carl T. Doman, Aircooled Motors, Inc., Syracuse, N. Y.; body, Rudolph I. Schonitzer, member A.S.M.E., Schonitzer Engineering Company, Cleveland, Ohio; Diesel engine, George M. Lange, Ex-Cell-O Corporation, Detroit, Mich.; fuels and lubricants, John M. Campbell, member A.S.M.E., General Motors Corporation, Detroit, Mich.; passenger car, W. H. Graves, Packard Motor Car Company, Detroit, Mich.; production, Stephen Johnson, Jr., Bendix-Westinghouse Automotive Air Brake Company, Elyria, Ohio; tractor and farm machinery, B. G. Van Zee, Minneapolis Moline Power Implement Company, Minneapolis, Minn.; transportation and maintenance, D. K. Wilson, New York Power and Light Corporation, Albany, N. Y.; truck and bus, Schuyler A. Jefferies, The Studebaker Corporation, South Bend, Ind.

B. B. Bachman, member A.S.M.E., Autocar Company, Ardmore, Pa., was re-elected treasurer. Three new members of the S.A.E. Council for 1947-1948 were elected as follows:

Marcus L. Brown, Jr., Toronto, Ont.; Elmer McCormick, Waterloo, Iowa; and Charles H. Miller, Cleveland, Ohio.

Qualifications and Duties of A.S.M.E. Council Members Outlined

AT its meeting on Nov. 7, 1946, the Executive Committee of the Council of The American Society of Mechanical Engineers approved a statement on "Qualifications and Duties of Council Members." The A.S.M.E. Nominating Committee urges members to consider the following statement in making proposals for 1948 nominees. Proposals should be sent to the Committee as soon as possible. The statement follows:

Membership of the Council

The President, eight Vice-Presidents, eight Directors, and the last five surviving Past-Presidents are members of the Council, the traditional name used by the Society to designate its board of directors. As directors, they are responsible individually and collectively for the administration of the Society. They are the trustees for the Society, a corporation with more than a million dollars in assets and an annual income of more than \$800,000. The members of the Council are regarded by the members of the Society and the public as leaders in their profession.

As directors, trustees, and leaders, they are expected to possess those qualities of character, vision, leadership, responsibility, and broad understanding that will justify the faith of the members in selecting them as directors. As these men must stand before the public, they should preferably possess abilities of dignified public address.

Customarily the Council meets at the Annual and Semi-Annual meetings. At the Spring and Fall meetings, members of the Council living near the meeting place usually join with the Executive Committee in the discussion of Society business.

The Executive Committee made up of a President, two Vice-Presidents and two Directors, holds regular monthly sessions and acts for the Council between its meetings.

Each Vice-President is selected from a particular Region and is expected to serve as the leader of the Society in that Region, exercising supervision over the activities of the Sections, Student Branches, and Membership Development. This service requires the expenditure of a substantial amount of time and this should be known by the nominee for a position on Council. The Vice-President is expected to meet and correspond with officers of the Sections and Student Branches, extend Society program and policy, and stimulate activities. In addition, two Vice-Presidents serve on the Executive Committee.

In addition to their duties as members of the Council, Directors are also assigned to the Boards on Technology, Codes and Standards, Membership, Honors, Education and Professional Status, and to the Committees on Organization and Finance. Boards are expected to meet at least quarterly and the Committees on Organization and on Finance meet monthly. The Directors who serve on these Committees and Boards must have the necessary amount of time to attend the meetings, and for the discharge of their other duties in connection therewith.

The ballots for election are canvassed on the fourth Tuesday in September. Although the new officers do not assume their responsibilities until the final day of the Annual Meeting (usually the first week in December), the President should have time available between the date of his election and the Annual Meeting to give a great deal of attention to the organization of the Society's committees for the ensuing year and for the study of current Society problems and activities.

Council Members Serve Without Compensation

The members of the Council serve without compensation. The President has a small fund for his expenses and an allowance is made toward the traveling expenses of the members of the Council when they attend meetings of the Council. No traveling expenses are allowed for attendance at meetings of the Executive Committee, Finance Committee, Organization Committee, or Boards. Small amounts are available for traveling to visit Sections and Student Branches. Each member of Council should have facilities in his personal office to permit him to handle routine Society matters promptly. Some financial sacrifice is therefore involved in service on the Council.

The Society covers a wide field of activity. Its committee structure is large. Its responsibility for leadership and progressive development of the profession is great. While intimate knowledge of and experience with one activity of the Society may be helpful, a willingness to study the broad field of Society work and become familiar with its ramifications is even more important.

In summary, members selected to serve on the Council should possess time to do the job, ability to make some financial sacrifice, willingness to study the work of the Society, but, above all, those qualities of character, vision, leadership, responsibility, and broad understanding that a great professional body must have in its directors.

Manhattan Engineer Project Transferred to Civilian Control

Hartley Rowe on Advisory Committee

AT midnight, Dec. 31, 1946, control of the Manhattan Engineer Project and with it the destinies of America's atomic-energy production passed from military to civilian control. The two-billion dollar project which at its peak during the war employed half a million people now becomes the full-time responsibility of a five-man civilian United States Atomic Energy Commission, created by the Atomic Energy Act of 1946 and appointed by President Truman in October, 1946.

The transfer of control was effected by an executive order signed by the President in the presence of Robert P. Patterson, Secretary of War, David E. Lilienthal, head of the civilian Commission, and other military and civilian officials.

Secretary Patterson pledged to the new civilian Commission the continuing wholehearted co-operation and support of the Army.

Speaking for the Commission, Mr. Lilienthal said that the people of the United States were turning over to five civilians the most potent weapon of all time. The Commission, he said, would pursue the peaceful and beneficial possibilities of the great discovery.

The gigantic organization taken over by the Commission extends over 18 states and includes the great plant at Oak Ridge, Tenn., the Hanford Engineer Works, Richland, Wash., the Argonne National Laboratory, Chicago, Ill., and extensive supervisory functions over work at various college and university laboratories. The transfer of personnel involved 254 officers, of whom 76 are of the regular army, 8 of the regular Navy, and 1688 enlisted men, 3950 civilian government employees and more than 37,000 others employed by contract operators.

The Commission is also taking over unexpended funds of the Manhattan Engineer Project and will maintain temporary offices in the new War Department Building until now headquarters of Major-General Leslie R. Groves, who commanded the project since Sept. 17, 1942.

Civilian Organization

In addition to the five-man civilian Commission who are charged with determination of policy, the Atomic Act of 1946 calls for a General Advisory Committee, composed of nine civilian scientists appointed by the President for a term of six years to advise the Commission on scientific and technical matters, a general manager appointed by the President to administer the policies of the Commission, and four directors, appointed by the Commission itself to take charge of the following divisions: research, production, engineering, and military application.

The Armed Forces will continue to have a voice in proposing what developments they wish from the atomic-energy projects. If any serious impasse develops between military and civilian interest the law provides machinery for the Armed Forces to protest to the President. In addition to a Military Liaison Committee, appointed by the Secretaries of the Army and Navy, the law provides that the director of the Division of Military Application be a member of the armed forces.

A.S.M.E. Member on Advisory Committee

Hartley Rowe, member A.S.M.E., vice-president and chief engineer, United Fruit Company, Boston, Mass., was among the nine scientists and engineers appointed by President Harry Truman to advise the recently appointed Atomic Energy Commission on the technical aspects of nuclear energy.

The advisers who are designated as "A General Advisory Committee," were specifically authorized by the President to consult with the Commission on "scientific and technical matters relating to materials, production, and research and development."

Other members of the General Advisory Committee are: James Bryant Conant, president, Harvard University; Lee A. DuBridge, president, California Institute of Technology; Ernico Fermi, professor of physics, University of Chicago; I. I. Rabi, professor of physics, Columbia University; J. R. Oppenheimer, war-time director of the Los Alamos Laboratory of the Manhattan Project, professor of theoretical physics, University of California; Glenn T. Seaborg, professor of chemistry, University of California; Cyril Stanley Smith, director, Institute of Metals, University of Chicago; and Hood Worthington, chemical engineer, E. I. du Pont de Nemours and Company.

Carroll L. Wilson Appointed Manager

On Dec. 30, President Truman appointed Carroll L. Wilson general manager of the Atomic Energy Commission.

The 36-year-old engineer, recommended to the post by Mr. Lilienthal, chairman of the Commission, as "the best qualified man," is a graduate of the Massachusetts Institute of Technology, who for eight years served as assistant to Dr. Karl T. Compton, president of the Institute. It was during these years that Dr. Compton served as chairman of the E.C.P.D. Committee on Engineering Schools and initiated the E.C.P.D. project of accrediting engineering curricula. Mr. Wilson carried on a considerable portion of the work of assembling data on engineering schools and curricula and became well known to engineers interested in education. In 1936 he became special assistant to Dr. Vannevar Bush, an association which continued when in 1940 Mr. Wilson became one of the original members of the National Defense Research Committee. Later he was executive assistant to Dr. Bush in the Office of Research and Development. Loaned to the State Department by that office, he assisted in the preparation of the Acheson-Lilienthal report on atomic-energy control. Since establishment of the Commission in October, Mr. Wilson has been connected with it as consultant.

Labor Policy

Following its first meeting with the General Advisory Committee on Jan. 3, the Commission announced that it has retained as consultants, three of the nation's leading specialists in the field of industrial relations and that it would follow the policy of close co-ordination with labor leaders to insure the soundest possible labor-management relationships in the far-flung atomic-energy facilities.

Those retained were: Lloyd K. Garrison, former chairman, War Labor Board; George H. Taylor, professor of industrial relations, University of Pennsylvania; and David A. Morse, Assistant Secretary of Labor and former general counsel, National Labor Relations Board.

Other Appointments to Follow

One of the first tasks of the Advisory Committees assigned to it by the Atomic Energy Commission was to find a director of research, one of four jobs to be filled. The other vacant posts are directors of production, engineering, and military application.

American Standards Association First to Ratify I.S.O. Constitution

Many Projects Proposed

THE United States has become the first country to ratify the convention setting up the 25-nation International Organization for Standardization (I.S.O.), according to P. G. Agnew, vice-president and secretary, American Standards Association. Action was taken at a recent meeting of the directors of A.S.A.

Dr. Agnew revealed he had received cabled notice from Charles le Maistre, secretary, United Nations Standards Co-Ordinating Committee, which continues in existence until the I.S.O. office is set up at Geneva, Switzerland, that the United States was first under the wire with its official acceptance of the new constitution and by-laws.

"In a series of four international meetings covering a year, many misconceptions were swept away and a solid basis of agreement was reached on the part which international standards can play in freeing the flow of international trade and so raising the living standard of all peoples everywhere," Dr. Agnew said.

"The organization of the I.S.O. marks a new phase in international co-operation," Dr. Agnew declared. "In the past, international standards were pioneered by engineering

groups. Now organized industry is taking an active and vigorous role in all of the countries, not only those that are highly industrialized, but also those which are using standards as a tool to speed their full entrance into the modern industrial world."

The pressure for standardization work which will aid the flow of goods in international trade has been so great, Dr. Agnew said, that scores of projects are being proposed for I.S.O. action.

The wide range of interest displayed was indicated, he said, in a list of 64 projects now accepted for I.S.O. action. Seventeen nations have accepted the technical leadership in forwarding one or more of these projects. In each case technical leadership in a given project will be taken by a country in which the industry concerned is well developed.

These projects include: Metal food containers, iron and steel, rubber (United Kingdom); methods of testing petroleum products, agricultural machinery, still photography, moving pictures, definition of the term "rayon" (United States of America); timber grading and classification of defects, surface finish of metal surfaces (Union of Socialist Soviet Republics); metric and inch threads, ball and roller bearings, modular building planning (Sweden); bolts and nuts (Poland); sheet and wire gages (Australia); gears, couplings, commercial zinc (Belgium); nonmetallic packaging of frozen foods (Norway); limits and fits, tools, automobiles, machine tools, tests for building materials (France); aircraft and airfield lighting, copper and copper alloys (Canada); ocean navigation, pigments, raw materials for paints, rivets (Holland); pipes (Switzerland); shellac, mica (India); methods of analysis of essential oils (Brazil); sprinkler plants (Austria).

1947 A.S.M.E. Committee Personnel List Sent on Request

MEMBERS of The American Society of Mechanical Engineers who wish to receive a copy of the 1947 issue of the Society Records containing committee personnel are requested to fill out and mail the accompanying form, or order by letter, addressed to the Secretary, A.S.M.E., 29 West 39th Street, New York 18, N. Y.

This issue, to be published in February, will form a part of the Society Records Section of the Transactions as bound for library use.

A.S.M.E., 29 West 39th St.
New York 18, N. Y.

Please send me a copy of the February, 1947, issue of the Society Records.

NAME..............................

ADDRESS..............................

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Rare A.S.M.E. Pin Recalls Early Days of Society

AN A.S.M.E. pin of unfamiliar design brought to the 1946 Annual Meeting by Howard W. Smith, fifty-year member, A.S.M.E., Ellwood City, Pa., has thrown some light on the time when only members and associates of the Society were privileged to wear the clover-leaf emblem.

A.S.M.E. BADGES

(*Left:* Large-size charm badge; *center,* lapel button; *right,* old-time junior-member pin.)

The circular pin, designed for junior members, was used for a short period in the 1890's when the Society placed emphasis on grades of membership, rather than on membership. Later, when this emphasis shifted, the circular pin was discontinued.

A reading of the old script of the minutes of the Council for the year 1880 and 1881 reveals that the founders showed early interest in some visual token of membership. Membership diplomas and A.S.M.E. clover-leaf badges date from these early days.

In May, 1881, while the Society was considering a design for a badge, the Spring Meeting was held in Hartford, Conn. The menu for the banquet, and all literature for the meeting were decorated with a four-leaf clover symbol bearing the initials of the Society arranged clockwise on the petals. The members of the young Society found the symbol so appropriate that they adopted it without material change as the official badge of the A.S.M.E.

Until 1900 it was the practice of members who were elected to office to wear the badge with a red background, but because of the trouble involved in changing badges and the general preference for blue as the background color, the practice was dropped.

A.S.M.E. members who visited the Paris Exposition of 1889 were much impressed by the design of a lapel button used by the French to designate visitors. For several years following the exposition, the Society used lapel buttons at its Annual Meetings rather than the "flamboyant silken banner" which served as the usual convention badge of the time.

The Annual Meeting lapel buttons, which were reproductions or derivatives of the French design, were restricted to members. Guests were identified by a pin with the initials M.E. worked into a scroll.

The Society has no record of the design of these Annual Meeting buttons or guest pins. Fifty-year members of the A.S.M.E. are asked to send in to Headquarters for preservation any rare mementos of the early days of the Society which they may find among their possessions.

Mr. Smith's junior-member pin and the current design of A.S.M.E. badges are shown in the illustration on this page. The current badges are made as pins, buttons, and charms. Pins and charms are made in large and small sizes. The lapel button is made only in the small size. Grades of membership in the badges are designated by the color of background—maroon for juniors, dark green for associates, blue for members, and gold for fellows. The badges are for sale at Headquarters at prices ranging from $2 to $5, according to the size and design of badge.

West Coast Meeting Planned by A.S.M.E. Boiler Code Committee

THE A.S.M.E. Boiler Code Committee is making plans to hold one of its regular monthly meetings in Los Angeles, Calif., sometime during the first week in May, 1947. Only on two other occasions in its history has the Committee departed from its rule of holding meetings in New York, N. Y.

The two-day meeting will follow the 1947 annual meeting of the National Board of Boiler and Pressure Vessel Inspectors. The first day will be devoted to a regular business session and the second to a public hearing on the proposed revision of the Unfired Pressure Vessels Code, Section VIII.

Several considerations led to the West Coast meeting. The Committee wanted to make more generally available the opportunity for engineers to observe how it functions and to encourage engineers to participate in the public hearings it sponsors. Moreover, National Board members, most of whom are members of the Conference Committee of the Boiler Code Committee, will be able to stay over for the meeting.

The proposed revision of the Unfired Pressure Vessel-Code, Section VIII, involves an improvement in arrangement and broadening the content of the Code.

The meeting will be under the sponsorship of the A.S.M.E. Los Angeles Section.

The National Board of Boiler and Pressure Vessel Inspectors is the administrative counterpart of the A.S.M.E. Boiler Code Committee. It was organized in 1919 to enforce and administer uniformly the provisions of the A.S.M.E. Boiler Code and is composed of chief inspectors of states and municipalities that have adopted the A.S.M.E. Boiler Code.

Computation Laboratory Opened to Public

ENGINEERS visiting Boston, Mass., now have an opportunity to observe Harvard University's automatic sequence calculator in operation, from chairs and sofas provided for them in the visitors lobby of the new Compution Laboratory, which was opened to the public on Jan. 7, 1947.

The calculator is being operated 24 hours a day and seven days a week under terms of a Navy contract. Most of the 32 members of the operating staff began working with the calculator while in Navy uniform.

A.S.M.E. Code for Unfired Pressure Vessels[1]

Proposed Revision of Section VIII of the A.S.M.E. Boiler Construction Code

THE Special Committee of the Boiler Code Committee to Revise Section VIII has just completed its work on a proposed revision of the A.S.M.E. Unfired Pressure Vessel Code, and has presented its report in draft form to the Boiler Code Committee for approval.

The general arrangement of the new draft is quite similar to that followed by the API-ASME Code for Unfired Pressure Vessels. Some of the more important changes in text between the proposed revision and present Section VIII were outlined in the May, 1942, issue of MECHANICAL ENGINEERING, page 354.

Although the draft has been submitted to the members of the Boiler Code Committee, it has not been discussed by them and is therefore subject to possible change. However, the Committee has decided to release this draft for general distribution for critical review, in order to expedite the work as much as possible. Comments are invited from all interested parties, with the request that they be sent to the Secretary of the Boiler Code Committee.

Copies of this draft may be obtained from the A.S.M.E., 29 West 39th St., New York N. Y., at $1 per copy.

The personnel of the Special Committee is as follows: E. R. Fish, chairman, Hartford, Conn.; R. E. Cecil, Oakmont, Pa.; A. J. Ely, Elizabeth, N. J.; D. S. Jacobus, Montclair, N. J.; K. V. King, San Francisco, Calif.; C. O. Myers, Columbus, Ohio; D. B. Rossheim, New York, N. Y., Walter Samans, Philadelphia, Pa.; K. G. Jobson, New York, N. Y.; and J. W. Shields, secretary, Boiler Code Committee.

[1] NOTE: This proposed revision in no way affects the forthcoming issuance of the 1946 edition of the Unfired Pressure Vessels Code. There is no indication at present as to the date of the final adoption of the proposed revision.

A.S.M.E. Calendar

of Coming Events

March 2–5, 1947
A.S.M.E. Spring Meeting
Tulsa, Okla.

May 21–24, 1947
A.S.M.E. Oil and Gas Power Division Meeting
Cleveland, Ohio

May 26–29, 1947
A.S.M.E. Aviation Division Meeting
Los Angeles, Calif.

June 12–13, 1947
A.S.M.E. Wood Industries Division Meeting
Madison Wis.

June 16–19, 1947
A.S.M.E. Semi-Annual Meeting
Chicago, Ill.

Sept. 1–4, 1947
A.S.M.E. Fall Meeting
Salt Lake City, Utah

Oct. 6–8, 1947
A.S.M.E. Fuels Division Meeting
Houston, Texas

Dec. 2–5, 1947
A.S.M.E. Annual Meeting
New York, N. Y., or
Atlantic City, N. J.

A.S.M.E. Participates in Hotel Fire Safety Conference

THE American Society of Mechanical Engineers sent three delegates, including its president, to the National Conference on Hotel Fire Safety, held in the Benjamin Franklin Hotel, Philadelphia, Pa., Jan. 16, 1947.

A.S.M.E. delegates were: Eugene W. O'Brien, president A.S.M.E., W. R. C. Smith Publishing Company, Atlanta, Ga.; Arthur L. Brown, chief engineer, Associated Factory Mutual Fire Insurance Company, Boston, Mass.; and Albert C. Wood, consulting engineer, Albert C. Wood and Associates, Philadelphia, Pa.

The conference was called by the National Fire Protection Association to focus public attention on the hotel-fire problem and to provide specific information on how life safety in hotels could be improved.

A.I.M.E. 75th Anniversary Program to Study World Mineral Resources

A WORLD Conference on Mineral Resources will be held at the Waldorf-Astoria Hotel, New York, N. Y., March 17–19, 1947, in conjunction with the 75th Anniversary Celebration of the American Institute of Mining and Metallurgical Engineers.

The Conference will cover virtually every phase of the world situation with respect to iron and steel, coal, petroleum, nonferrous metals, and atomic energy. Delegates from every mineral-producing country have been invited and many will present papers.

According to Louis S. Gates, president, A.I.M.E., the Conference will consider the demands made upon world resources by the two recent wars; it will take cognizance of the increased responsibilities imposed upon mineral technology to replenish depleted mineral resources; and will explore new processes and new techniques to make feasible the economic recovery of minerals from the world's immense reserves of low-grade ores.

Herbert Hoover, ex-president U.S.A., and past-president A.I.M.E., will address the Conference at the A.I.M.E. anniversary banquet on March 19, 1947.

Among the speakers from abroad scheduled to address the conference will be Sir William Fraser, chairman, Anglo-Iranian Oil Company, Limited, who will speak on "International Aspects of the Petroleum Industry," and Pedro Beltran, former Peruvian ambassador to the United States, who will talk on "Tariffs, Cartels, and the Mineral Industry."

Harry A. Winne, member A.S.M.E., vice-president, General Electric Company, will participate in the session on "The Mineral Industry and Atomic Energy." His paper, prepared in collaboration with B. R. Prentice, will be on "Application of Atomic Energy to Industry."

Index to 1946 Volume of Mechanical Engineering

AS Section 2 of the January, 1946, issue of the Transactions of the A.S.M.E., separate indexes to the Transactions and to MECHANICAL ENGINEERING for 1946 were mailed to A.S.M.E. members receiving the Transactions of the Society.

An additional copy of the index to MECHANICAL ENGINEERING may be secured from A.S.M.E. Headquarters, 29 West 39th Street, New York 18, N. Y., by sending ten cents for handling charges.

Joint Action Between A.S.M.E. and E.I.C.

ON Dec. 5, 1946, at the Hotel Pennsylvania, New York, N. Y., the joint committee which was established under the co-operative agreement between The American Society of Mechanical Engineers and The Engineering Institute of Canada met to consider joint activities for 1947. The A.S.M.E. representatives were A. G. Christie, past-president, A. E. White, professor of metallurgical engineering, University of Michigan, and George A. Stetson, editor of MECHANICAL ENGINEERING. For the Institute, John G. Hall of Combustion Engineering, Ltd., Toronto, W. A. Newman of the Department of Research, Canadian Pacific Railway, Montreal, and L. Austin Wright, general secretary, E.I.C., were the representatives. The other representatives of the joint committee who, unfortunately, could not be present, were J. W. Parker, past-president, A.S. M.E., and Dr. O. W. Ellis, director, department of engineering and metallurgy, Ontario Foundation.

Preliminary arrangements were made for joint participation in the work of research and

code committees. Also for joint publication of technical papers and joint participation in professional meetings. Prompted by the success of the 1943 meeting a proposal to hold another joint professional meeting in 1948 is to be submitted to the governing bodies of both organizations.

The next meeting of the joint committee was set tentatively for Toronto in May, 1947, during the course of the annual meeting of the Institute.

A.I.E.E. Launches New Publication Policy

WITH its January, 1947, issue of *Electrical Engineering* the American Institute of Electrical Engineers inaugurated a new publication plan designed to give members more news and articles of general interest and at the same time provide them with more complete technical papers on subjects in the field of their specialty.

Because the electrical art is so broad in scope and specialized in nature, the A.I.E.E., even more so than the A.S.M.E., has been faced with the problem of how to publish and distribute important engineering papers which are of interest only to a relatively small group.

The A.I.E.E. plan calls for divorcing highly complicated technical papers from *Electrical Engineering* and publishing them in the form of individual printed pamphlets called A.I.E.E. Proceedings.

The novel feature of the plan is the scheme of distribution. While the monthly magazine, containing articles of general interest and news reflecting A.I.E.E. activities, will be sent to all A.I.E.E. members, the Proceedings will have only limited distribution.

As the individual pamphlets of the Proceedings are issued, each member will be given an opportunity to select for receipt free of charge a limited quantity of the total number issued. The Proceedings over and above the limited number will be available to each member at cost. The limiting number of free Proceedings has been selected to be sufficiently generous to enable the average member to obtain those papers in which he is most intimately concerned.

New Monthly Science Magazine Published by Government

THE first issue of *Federal Science Progress*, a new monthly magazine covering the field of government-sponsored scientific and technological research was released by the Government Printing Office on Jan. 7, 1947. Although edited primarily for the businessman who "takes an active part in guiding research activities of his company," the magazine should be of interest to scientists, engineers, and others who can benefit from a monthly report of the scientific and technical activities of the government.

The first issue, dated February, 1947, contains articles on aerial soil surveys, solar heating, synthetic oil, tropicalizing, and rockets by government scientists and officials.

The magazine is a project of the Office of Technical Services, Department of Commerce. It is 9 × 11 in. in size, 48 pages long, and is printed on a good grade of coated book stock. Extensive use is made of photographs and other illustrations, both black and white and two color. It has no commercial advertising content.

Although a government publication, the magazine is not to be given away free. Single copies and annual subscriptions are available through the Superintendent of Documents, Washington 25, D. C. The subscription price is $3. Single copies are $0.25.

The editors have this to say about the new magazine:

"The ultimate test of its worth is its service to the business community. The Department of Commerce has made a commitment to the Bureau of the Budget that publication will be discontinued if, after a reasonable period of time, the number of paid subscribers is insufficient to justify continuation.

"Before publication, the editors discussed the magazine with editors and publishers of a number of privately published scientific and business periodicals. None of them believed there would be competition, since we will limit our reporting to Government and Government-sponsored activities, and we will not take advantage of our status to print information before it is available to commercial publishers."

German Equipment to Aid Research in Powder Metallurgy

A HUNDRED tons of German machinery comprising a complete plant for the manufacture of cemented carbides is being shipped to the Stevens Institute of Technology, Hoboken, N. J., by the U. S. Ordnance Department for use in a Navy-sponsored research program on high-temperature alloys for use in rockets and jet engines.

The plant was shipped to this country as the result of the studies made of the German cemented-carbide industry and developments in iron powder metallurgy by Gregory J. Comstock, director of research, Stevens Powder Metallurgy Laboratory, who was in Germany as a member of the Allied Technical and Industrial Intelligence Commission.

The twelve machines, used for making armor-piercing projectiles with cemented-carbide cores, make available to the United States a fine tool for the development of new alloys and techniques.

The German equipment is designed for the hot-pressing method rather than the cold-pressing method which is used generally in the powder-metal industry here.

According to Professor Comstock, the German process is not necessarily better than ours, but it is different and warrants investigation. With the German machines and raw materials, he expects to reproduce the latest hot-pressing methods.

A temporary one-story frame structure adjacent to the Stevens Powder Metallurgy Laboratory has been constructed to receive the German machines.

A.I.S.E. Elects Officers

L. R. MILBURN, electrical engineer, Great Lakes Steel Corporation, Ecorse, Mich., has been elected president of the Association of Iron and Steel Engineers for 1947.

The Association was founded in 1907 to foster the exchange of ideas and to further the electrification of the iron and steel industry. The scope of its activities now embraces all divisions of steel-plant engineering and operation.

Other officers elected were: A. J. Fisher, C. H. Williams, A. S. Glossbrenner, and John F. Black.

Metropolitan Section Aims for Policy Statement

AS the first step toward formulation of a definite statement of policy on unionization and collective bargaining for engineers, which could be circulated among other sections for comment, the Metropolitan Section of the A.S.M.E. has submitted a questionnaire to its 3200 members, asking them how they feel about the subject and whether they want to express their views at a Section meeting.

Based on returns, H. R. Kessler, chairman, executive committee, A.S.M.E. Metropolitan Section, expects to plan a series of meetings at which all shades of opinion will be heard and reduced to one statement of policy reflecting the wishes of Metropolitan engineers.

The questionnaire was the result of a meeting on Nov. 8, 1946, during which the subject, "Organization of the Engineering Profession," was earnestly discussed late into the night.

In his letter to Metropolitan Section members, Mr. Kessler reviewed the work being done by the Engineers Joint Council on the economic status of engineers and referred to associations being formed by professional men on the East and West coasts directed toward improving the relative economic position of the technically trained.

J. F. Lincoln Honored

JAMES F. LINCOLN, member A.S.M.E., president, the Lincoln Electric Company, Cleveland, Ohio, received the 1945–1946 Samuel Wylie Miller Memorial Medal of the American Welding Society at the 27th annual banquet of the Society, Ambassador Hotel, Atlantic City, N. J., Nov. 21, 1946.

Found: A.S.M.E. Badge

AN A.S.M.E. "charm" badge with a blue background was found in one of the meeting rooms of the Pennsylvania Hotel during the Annual Meeting. It will be returned to owner upon written request to Headquarters.

Carnegie Tech to Build Two-Million-Volt Cyclotron

WITHIN two years the Carnegie Institute of Technology, Pittsburgh, Pa., expects to build on its campus a new 2,000,000-volt synchrocyclotron and a nuclear-research laboratory to house it, according to Robert E. Doherty, fellow A.S.M.E., and president of the Institute. The project is estimated to cost $550,000.

The new facilities have been made possible by a grant of $300,000 from the Buhl Foundation of Pittsburgh. Condition of the grant provides that at least $250,000 be subscribed by others for the same purpose.

The proposed accelerator, which is expected to be about four times as efficient as prewar machines, will have 110-inch poles, and will be exceeded in size only by the 184-inch cyclotron at the University of California, Berkeley, Calif.

Czechoslovakian Engineers Support W.E.C.

ACCORDING to Aristide Antoine, president of the recently organized World Engineering Conference, engineers in Czechoslovakia were among the first to set up a national committee to the W.E.C.

Mr. Antoine, who attended the Polish Engineering Congress, Kotowice, Poland, which was held Dec. 1 to 3, 1946, to explain the country's economic plan for the next four years to the engineering profession, discussed the work of the W.E.C. with Boleslaw Biminski, president of the General Federation of Polish Engineers, and other delegates from Yugoslavia, Bulgaria, and Hungary.

An account of E.J.C. action on the proposed organization of an American national committee to the World Engineering Conference is published on page 170 of this issue.

Spectroscopy Laboratory Expanded at M.I.T.

THE value of the spectroscope as a research tool in all basic sciences is reflected in the reconversion plans of the Massachusetts Institute of Technology.

The Spectroscopy Laboratory, formerly a part of the Research Laboratory of Physics, is being reorganized as an independent entity, with considerable expansion of facilities, under the office of the dean of science.

The laboratory will be made available to research workers in biology, chemistry, geology, and metallurgy, as well as physics. Specific research programs have been planned in the fields of wave-length and intensity measurements, and ultraviolet, visible, and infrared absorption spectrophotometry. Among these will be researches sponsored by the Office of Naval Research and the American Petroleum Institute. Richard C. Lord is director of the Spectroscopy Laboratory.

ARTHUR E. GRUNERT, MEMBER A.S.M.E.

Arthur E. Grunert Promoted

ARTHUR E. Grunert, member A.S.M.E., Melville Medalist, 1931, has been promoted to chief operating engineer of the Commonwealth Edison Company, Chicago, Ill. He assumed his new post on January 1.

Mr. Grunert started his utility career in 1908 as a draftsman and subsequently became a testing engineer, boiler-room engineer, efficiency engineer, and superintendent of generating stations. He was made assistant chief operating engineer in 1943.

Mr. Grunert is an engineering graduate of the University of Wisconsin.

Suggestions for Code Revision Requested

THE Safety Code for Elevators (A17.3-1942), sponsored jointly by the American Institute of Architects, the National Bureau of Standards, and The American Society of Mechanical Engineers, is now being revised. The usual periodic revision scheduled for 1943 was held in abeyance due to the pressure of war work.

At present ten subcommittees are at work on particular phases of this revision. Suggested rearrangements, modification of existing rules, or proposals for additional material will be welcome and will be referred to appropriate subcommittees for consideration. All communications should be addressed to The American Society of Mechanical Engineers, attention C. B. LePage, Assistant Secretary, 29 West 39th Street, New York 18, N. Y.; to the American Institute of Architects, attention Theodore I. Coe, Technical Secretary, 1741 New York Avenue, N.W., Washington 6, D. C.; or to the National Bureau of Standards, Washington 25, D. C., attention of J. A. Dickinson, secretary of the sectional committee.

It is the hope of the sectional committee in charge of this work that the 1947 edition will be clearer in intent, fuller in coverage than previous editions, and will be arranged so as to require the minimum number of cross references.

Meetings and Expositions of Other Societies

Feb. 16–19
American Institute of Chemical Engineers, Louisville Regional Meeting, Brown Hotel, Louisville, Ky.

Feb. 24–26
American Management Association, Personnel Meeting, Palmer House, Chicago, Ill.

Feb. 24–27
Technical Association, Pulp and Paper Industry, Annual Meeting, Hotel Commodore, New York, N. Y.

Feb. 24–28
American Society for Testing Materials, Spring Meeting and Committee Week, Benjamin Franklin Hotel, Philadelphia, Pa.

March 19–22
American Society of Tool Engineers, Annual Meeting, Rice Hotel, Houston, Texas.

March 21–22
The Society for the Advancement of Management, Statesmanship in Management Meeting, Ambassadore Hotel, Los Angeles, Calif.

March 22–27
American Welding Society, District Meeting in conjunction with Western Metal Congress, Oakland, Calif.

March 22–27
American Society for Metals, Western Metal Congress and Exposition, Oakland, Calif.

March 25–28
Greater New York Safety Council, 17th Annual Safety Convention and Exposition, Hotel Pennsylvania, New York, N. Y.

April 8–11
American Management Association, Packaging Meeting and Exposition, Convention Hall, Philadelphia, Pa.

April 9–11
Society of Automotive Engineers, Aeronautic Meeting, Hotel New Yorker, New York, N. Y.

April 14–18
American Chemical Society, 111th National Meeting, Hotel Traymore and Convention Hall, Atlantic City, N. J.

April 16–18
Society of Automotive Engineers, Transportation Meeting, Hotel Stevens, Chicago, Ill.

April 18–19
The Society for the Advancement of Management, Time Study and Methods Meeting, Hotel Pennsylvania, New York, N. Y.

April 21–22
American Management Association, Production Meeting, Hotel New Yorker, New York, N. Y.

Sections

A.S.M.E. Sections Study Problems of Urban Smoke Control

Pittsburgh and Peoria Engineers Hold Meetings

TWO meetings close in spirit to the theme of the A.S.M.E. 1946 Annual Meeting were held within a few days of each other in two cities where man and nature unwittingly conspire to create the depressing public nuisance—smoke, smog, and atmospheric pollution.

In Pittsburgh, Pa., on Dec. 9, 1946, three hundred engineers and guests met at the William Penn Hotel in a public meeting sponsored by the A.S.M.E. Pittsburgh Section, to hear what smoke-ordinance officials, fuel suppliers, and fuel users think and are doing to cope with the problem.

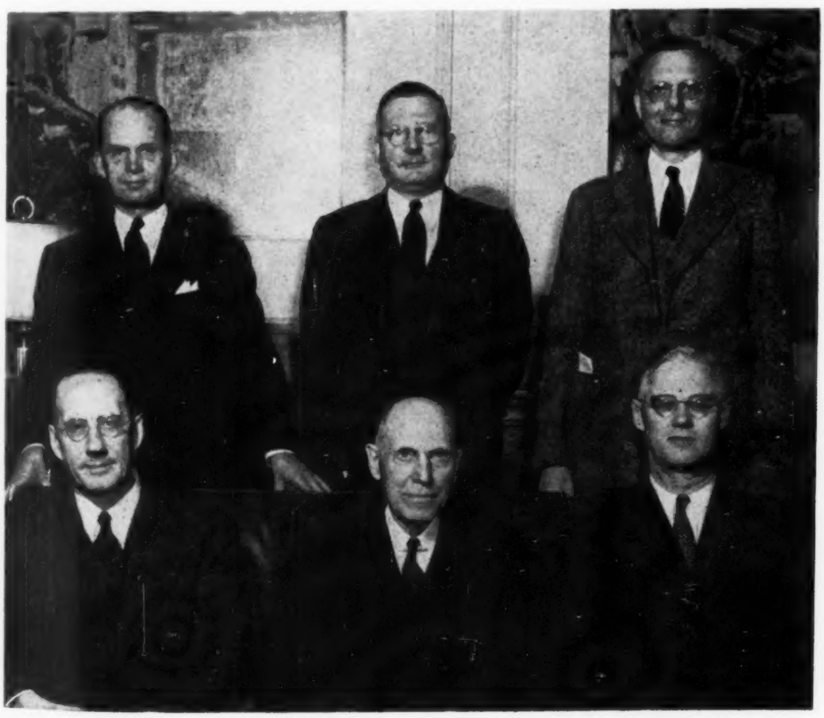
In Peoria, Ill., on Dec. 12, sixty engineers attended a dinner at the Jefferson Hotel, sponsored by the A.S.M.E. Central Illinois Section, at which they explored such practical questions as: How do you determine what is too much smoke? What constitutes a smoke violation? and, How do you punish a violator?

While the engineer can do and has done much to eliminate smoke by proper combustion of fuel, the discussions revealed that sources of smoke are so many, meteorological phenomena so uncontrollable, and topographical conditions of an area so important a factor, that the smoke-abatement problem is tremendously complex and the combined skills of combustion engineers, climatologists, doctors, economists, statisticians, and chemists, are required to find the solution.

Inversion Phenomenon

At the Pittsburgh meeting four speakers were invited to present the points of view of the City's Bureau of Smoke Prevention, coal suppliers, steel industry, public utilities, and the railroads.

Sumner B. Ely, Fifty-Year Member of the A.S.M.E., superintendent, Bureau of Smoke Prevention, Pittsburgh, Pa., opened the discussion with a talk on the general aspects of smoke elimination in the Pittsburgh area.



OFFICERS OF THE A.S.M.E. PITTSBURGH SECTION AND SOME OF THE SPEAKERS WHO PARTICIPATED IN THE SMOKE ABATEMENT SYMPOSIUM ON DEC. 9, 1946

(*Front row, left to right:* W. N. Flanagan, Carnegie Illinois Steel Company, Prof. S. B. Ely, superintendent, Bureau of Smoke Prevention; and R. B. Donworth, Duquesne Light Company. *Back row, left to right:* T. Fort, chairman, A.S.M.E. Pittsburgh Section; T. J. Barry, chairman, Entertainment Committee; and E. W. Jacobson, chairman, Program Committee.)

Pittsburgh's smog, he explained, was caused by fog and the meteorological condition called an "inversion" which develops when the ground stratum of air is cooled by the earth until it is cooler than the strata above it. It then remains static and collects all the fumes and smoke discharged by industrial, commercial, and domestic furnaces.

Dr. Ely pointed out that in 1946 a city smoke-prevention ordinance went into effect against all industrial and commercial establishments, and that late in 1947 domestic users will be required to use smokeless fuel or convert to equipment which will eliminate smoke from home fuel-firing installations.

Some Factors Rarely Considered

As a representative of the coal suppliers, Henry Hebley, member A.S.M.E., director of research, Pittsburgh Coal Company, reviewed different methods tried by communities to solve the smoke problem. Because smoke impairs health, increases cost of living, and injures flora in urban areas, discussion of the subject often becomes highly controversial and so charged with emotional thinking that objectives become obscure.

He called for sober evaluation of all the complex factors involved. Scientific surveys of atmospheric pollution present almost insurmountable problems with regard to sources and quantitive determinations. Air pollution originating at midnight at Youngstown, Ohio, carried on a wind of velocity of 10 miles per hour, can be over Pittsburgh in the morning, while the City's pollution can be carried to some other section.

Mr. Hebley called attention to the inadequacies of the Ringelman chart so widely used in this country for judging pollution.

Air pollution is not only a problem of smoke and dust, be said, but also of condensation nuclei which promote formation of fog. All combustion processes in furnaces and transportation facilities, whether they use solid, liquid, or gaseous fuels, are copious producers of such nuclei. While fog will not form in pure air until relative humidity reaches the saturation point, great concentration of nuclei in atmospheres of humidities above 80 per cent will cause bad haze and fog.

Condensation nuclei composed of sulphur dioxide are the most serious because under the action of sunlight they combine with water to form sulphuric acid. This corrodes city structures and causes an irritating and biting sensation in the throat.

Mr. Hebley concluded by saying that ordinances are the only means of policing an area but they will not solve the smoke problem. What is needed is a carefully planned program of investigation and research considered from a long-range point of view. Such a program should call into play a wide range of skills in addition to those of the engineer.

Smokeless Fuels in Steel Industry

The point of view of the steel industry, the largest single consumer of fuel in the Pittsburgh area, was presented by W. N. Flanagan, member A.S.M.E., consulting engineer, Carnegie-Illinois Steel Corporation. Because complete combustion of fuel is a matter of money to the steel industry,

great advances have been made since 1900 in the reduction of coal per ton of steel produced. In 1901 three tons of bituminous coal were consumed per ton of product, while in 1945 the rate was 1.375. As soon as modernization programs are completed, a rate of one ton of coal per ton of product is expected.

Great advances have been made in the art of coke production. With the practical elimination of bee-hive coke ovens and the refinements in by-product coke plants, smoke and fumes formerly discharged into the atmosphere are now reclaimed as useful chemicals and non-smoking coke-oven gas. The new fuel provided in this manner permits elimination of coal for steelmaking and steel-heating.

Dust, too, since it is composed of valuable materials, is of considerable economic importance to the industry. Only limitations of commercially available equipment limit the industry's dust-elimination program.

In spite of the shutdown of all steel works in Allegheny County early in 1946, smoggy days continued to occur in Pittsburgh. As communities improve domestic conditions, the steel plants will be better able to observe their contribution to atmospheric pollution. At any rate, economic laws impel the industry to eliminate or recover valuable products of combustion.

R. B. Donworth, Duquesne Light Company, speaking for the utilities, said that power companies have an economic interest in smoke prevention. His company, he said, discovered that the loss of one per cent of the volatility of its coal up the stack could mean a cost of $30,000 on its coal bill.

Referring to the City's smoke prevention ordinance, Rufus Flinn, Pennsylvania Railroad Company, who spoke for the railroads, said that a county law should take precedence over the present-day city law so that a uniform standard ordinance would be established.

Central Illinois Section Meeting

At the meeting in Peoria, Ill, Carroll F. Hardy, member A.S.M.E., chief engineer, Appalachian Coals, Inc., spoke on smoke abatement as a civic enterprise. He was followed by R. F. Phipps, Peoria's new smoke commissioner, who explained how the city's smoke ordinance operates.

Mr. Hardy confined himself largely to analysis of what makes the most smoke and how it can be controlled. He based his statements on a recent survey of 20 industrial cities across the nation, saying that the results obtained seemed to fit the conditions at Peoria as well.

Dump Equals 5000 Homes

In the survey, city plants, such as the fire hall, city hall, city schools, and the city dumps were often worst offenders.

"One dump on the edge of the city makes more smoke than 5000 homes," Mr. Hardy claimed.

Hand-firing of furnaces and boilers, which causes more smoke than when stokers are used, was most frequent in schools and churches which have 74 per cent hand-firing. Hospitals and hotels show 33 per cent; small industries, 48 per cent; larger industries, only 20 per cent.

"As a rule," said Mr. Hardy, "larger plants are usually best since they have better equipment to use and more competent engineers to fire their generators."

He said the survey also showed that 64 per cent of the men firing furnaces weren't able even to see their stack, hence weren't interested in how much smoke might be pouring from it.

Industrial City Problem

Reversing the old proverb somewhat, Mr. Hardy pointed out that where there's smoke, there's industry.

"I know of no industrial city that does not have a smoke problem," he said.

Some of the leading factors to be considered in how likely your city is to have "smog" are these: 1 Where are the dense areas of population? Do you have tenement areas? 2 What is the type and location of your industry? 3 How does geography affect the situation? (In Peoria, for instance, the bluffs and the river tend to hold the smoke in this area.) 4 How do wind directions affect the problem? 5 What is the consumption of coal? (Peoria burns 400,000 tons per square mile, about the same as Pittsburgh.)

Mr. Hardy claimed that stokers and more modern equipment could "cure" the smoke nuisance, and added that Peoria had a "reasonably good ordinance" to begin with.

City Code Operation

When questions in the open forum became too localized for Mr. Hardy, Mr. Phipps explained how the city code will operate. On a basis of scientific tests for smoke density,

The Peoria Journal

PEORIA, ILL., ENGINEERS STUDY SMOKE CONTROL

(*Standing, left to right:* C. A. Davis, chairman, A.S.M.E. Central Illinois Section; R. F. Phipps, smoke commissioner, Peoria, Ill.; Wm. F. Biggs, chairman, Technical Committee, A.S.M.E. Central Illinois Section. *Seated:* Carroll F. Hardy, member A.S.M.E., chief engineer, Appalachian Coals, Inc., speaker.)

stacks have a range from a No. 1 to a No. 5 "blackout" smoke. The aim of the ordinance is to keep smoke below the No. 2 smoke density.

On the pertinent question of fly ash, Mr. Phipps explained that it must be kept at "15 per cent of the ash of the fuel as fired by the stack. No more."

Following his detailed explanation of "allowable emissions" from industry stacks, engineers wanted to know how the smoke department proposed to "check" smoke density, or even determine it.

Burden of Proof

"Jailing" of the violator seemed out of the question and Mr. Phipps admitted that burden of proof of violation would be upon the department itself. In the majority of cases he hoped, he said, that "good faith" would be shown by those with corrections to make in their firing systems.

William F. Biggs, member A.S.M.E., was chairman of the meeting.

"Radiant Heating" Topic at Akron-Canton Section

At the Dec. 12 meeting in the Akron Y.W.C.A., Akron, Ohio, Robert L. Schindel, Jr., spoke on "Radiant Heating." Mr. Schindel first showed a film entitled "Eternally Yours," which portrayed the history of wrought iron down to the present day. This film was produced by A. M. Byers Company. Mr. Schindel then explained the use of wrought-iron pipe in radiant heating. His talk embraced the theory and development of radiant heating; the calculation and design of radiant-heating systems; and current installation practices. Fifty-two were present.

Anthracite-Lehigh Valley Section

On Nov. 8 at the Bethlehem Steel Club, Hellertown, Pa., the Section held a student smoker for members of Lehigh University and Lafayette College branches. The speaker was Rev. C. R. Rahn who talked on "Nerve Oil." Rev. Rahn suggested that the bearings of modern living might well be lubricated with his own brand of Nerve Oil, made up of patience, good will, and good humor. His talk was extremely well received by the audience of 69.

Joint Meeting of Cincinnati Section and A.I.E.E.

On Dec. 5 a joint meeting was held with the Cincinnati Section, A.I.E.E., in the Engineering Societies Building, Cincinnati, Ohio. The speaker was Cassius M. Davis, manager, transportation-engineering division of General Motors, and his subject "Gas and Steam Turbine Locomotives." Mr. Davis traced the theory of turbine drives, pointing out basic similarities. He explained differences in operating characteristics of direct-drive (through gears, jack-shafting, etc.) versus electrical or hydraulic-coupled drive; the advantages and limitations inherent in each. He had slides to show curves, designs, and actual locomotives. Between 150 and 200 members and guests attended.

Aerial Photography Shown at Dayton Section

On Dec. 4 at the Engineers' Club, Dayton, Ohio, Col. George W. Goddard, chief of the photographic laboratory at Wright Field, gave a talk on "Aerial Photography in World War II." The speaker showed tridimensional films taken by B-29's over Japan at the close of the Pacific war. The films, taken at an altitude of 10,000 ft, showed in color the minutest details of terrain and buildings. Viewed through polaroid glasses, the pictures that flashed on the screen outlined clearly buildings, trees, roads, and lakes, showing the objects in all their dimensions. Colonel Goddard explained that this newest type camera achieves its effect by shooting the picture through two lenses. The polaroid glasses then help bring the images together into the tridimensional final product. Sixty members and 90 visitors enjoyed the program.

Interesting Meetings at Fort Wayne Section

"Theory of Operation, Field Servicing and Use of Expansion Values" was the subject at the Nov. 7 meeting in the Fort Wayne Athletic Club, Fort Wayne, Ind. An audience of 50 heard F. Y. Carter of the Detroit Lubricator Company, tell of the theory, the servicing, and use of expansion values in refrigerator systems. Mr. Carter showed three films and a set of slides to accompany his talk.

At the Dec. 5 meeting F. B. Stern, member A.S.M.E., project engineer, Magnaflux Corporation, Chicago, Ill., spoke on "Strength Engineering." This talk included a discussion of experimental stress analysis through the use of a stress coat (a brittle coating), and the benefit of such an analysis on weight of material, reduction, residual stress, metallurgy, and quality control. Forty members were present.

Inland Empire Section Hears Talk on Riveted Structures for Welding

On Dec. 7 a meeting was held in the Desert Oasis, Spokane, Wash., at which Dr. W. A. Pearl spoke on "Redesign of Riveted Structures for Welding." He explained that welded structures such as bridge cranes, save design and construction labor, and weight. Welded cranes, he said, have withstood the severest tests. The most difficult problem has been to convert engineering personnel from riveted to welded design. Ten members and one guest were present.

Nuclear Power Studies at Ithaca Section

On Nov. 21 a meeting was held at Cornell University, Ithaca, N. Y., attended by 80 members and guests. G. W. Dunlap gave a talk on "New Instruments for Nuclear Power Studies," which indicated the present studies being made to utilize nuclear energy for power developments, the present status of the science, the instruments and equipment being used to augment nuclear-power studies, and some of the prospects and developments in nuclear power.

J. L. TRECKER, GUEST SPEAKER, GREETS MAX RUESS, CHAIRMAN, A.S.M.E. MILWAUKEE SECTION, AT DECEMBER MEETING

A.S.M.E. Vice-President Speaks at Louisville Section

On Nov. 21 at the Kentucky Hotel, Louisville, Ky., T. S. McEwan, vice-president, A.S.M.E. Region VI, spoke on "Problems Management is Facing." He told of the present problems of management in returning to normal peacetime production, revolving primarily around the difficulty of obtaining prewar efficiencies from employees. Labor unions and the attitude of labor were discussed at some length in a question-and-answer period following the talk. Twenty-eight were present.

Milwaukee Section Makes Plant Trip

On Dec. 11 the Section members were guest of the Kearney & Trecker Corporation at a dinner meeting, followed by an inspection trip. At the dinner the speaker was J. L. Trecker, executive vice-president, Kearney & Trecker Corporation, whose subject was "Modern Men Versus Obsolete Machines." One hundred and twenty members were present. Preceding the inspection trip, Dr. A. O. Schmidt, director of metal-cutting research, Kearney & Trecker, gave a short address, illustrated with slides, on the research and development work done by his company in the design of modern machine tools. Small groups of members were ushered through the plant and given demonstrations of the most modern methods of machining metals. Approximately 160 members and guests made the trip.

New Haven Section Meets With Yale University Branch

At the Dec. 6 meeting, which was a joint meeting with the Yale student branch, held in the United Illuminating Company's auditorium, New Haven, Conn., Eugene W. O'Brien, newly elected president, A.S.M.E., gave a stimulating talk entitled "Opportunities Lie About Us." Mr. O'Brien directed most of his remarks to the students but received an enthusiastic response from the older members as well. He advised the students to strive for a broad formal education and count on specializing later. A discussion period followed. Thirty-five members and students attended.

Dean W. R. Woolrich Speaks at North Texas Section

At the meeting on Dec. 12 in the Stonleigh Hotel, Dallas, Texas, Dean Willis R. Woolrich, of the University of Texas, gave a talk on "Refrigeration and Food Preservation: Past and Present." He traced the history of refrigeration from 1776 up to and including present-day quick-freeze processes. Slides accompanying the lecture presented an interesting story of early refrigeration developments which took place in England and the southern part of the United States. Sixty-three members and guests were in the audience.

Philadelphia Section Hears Dr. John I. Yellott

A special Professional Division meeting was held at the Frankford Arsenal Gage Laboratory, Philadelphia, Pa., on Nov. 19. Brig. Gen. E. C. MacMorland, commanding Frankford Arsenal, welcomed the Section members, and introduced the speaker, B. B. Patton, chief engineer of the Gage Laboratory, who gave a talk on "Precision Measurements for Industry." Following Mr. Patton's talk, the gathering was divided into groups, and the operations of the various dimensional quality-control tools in the laboratory were demonstrated. The latest American and captured enemy precision-measuring devices were included in this demonstration and a compendium of a proposed international system of expressing locational tolerances was distributed. The meeting was so well attended that Mr. Patton obligingly repeated his address later in the evening for the benefit of the overflow audience, thus concluding one of the most interesting and instructive visitation meetings held under the sponsorship of the Section.

On Nov. 26 at the Philadelphia Engineers Club, Philadelphia, Pa., Dr. John I. Yellott, member A.S.M.E., director of research, Locomotive Development Committee, Baltimore, Md., spoke on "Coal-Burning Gas Turbines." Dr. Yellott presented the story of a new development, which is commanding wide-spread technical interest, by the man who was instrumental in the design of the coal-burning turbine.

The subject at the meeting on Dec. 10 in the Edison Building, Philadelphia, Pa., was "Peacetime Applications of Atomic Energy and Its By-Products." There were two speakers: Dr. Edgar J. Murphy and C. A. Powell. Dr. Murphy gave a very illuminating talk on the potential applications of atomic energy to peacetime needs when directed into constructive channels. Mr. Powell then dealt with the practical use in the power-generating field. This was a combined meeting of the Section with the A.S.C.E., the latter acting as the host organization, and a total of 181 were present.

Unusual Program at Providence Section

On Dec. 3, 1946, in the Providence Engineering Building, a talk entitled "Three-Dimensional Pictures," was given by Mr. Ramsdell. Colored slides were shown and viewed with polarized glasses. Cameras for taking 3-dimensional pictures were described with slides. Advice was given to members submitting their slides for comment. The beautiful pictures shown were enjoyed by the 70 members and guests present.

Rock River Valley Section Holds Joint Meeting With A.I.E.E. and M.T.C.

On Dec. 2 a joint dinner meeting was held with the Madison Section, A.I.E.E., and the Madison Technical Club, in Christ Presbyterian Church, Madison, Wis. After dinner Pierce G. Ellis spoke on "Natural Gas for Wisconsin." This talk was based on a report on natural gas by the Milwaukee Engineering Society's Civic Affairs Committee, of which Mr. Ellis was chairman. Mr. Ellis, who is assistant to the general manager of the Wisconsin Public Service Company, covered the subject in an excellent manner. He told of the new pipeline being installed from Kansas and Texas to service Michigan, Wisconsin, and Illinois. E. R. Felber, vice-president of the Madison Gas and Electric Company, led the discussion which followed the talk. The audience totaled over 220.

Talk on Ram Jet Engine at Southern California Section

"Development of Subsonic Ram Jet Engine" was the subject at the Dec. 6 meeting in the University of Southern California, Los Angeles, Calif. The speaker, Don Wilson, assistant chief engineer, Marquardt Aircraft Company, after the showing of a ram jet engine on test, gave a complete treatise on the development of this type engine, with formulas and methods used to develop and to check results. A discussion period followed. The audience consisted of 186 members and 31 student members and visitors.

In the Rodger Young Auditorium, Los Angeles, Calif., on Dec. 12, a talk was given by Given Brewer, consulting engineer, specializing in stress analysis, and Dr. H. O. Fuchs, member A.S.M.E., assistant chief designer, Preco, Inc., Los Angeles, Calif., entitled "The Photogrid Process—Influences of Residual Stresses on Fatigue Life." Mr. Brewer explained the process of photographing reference lines on metal to be worked in order to study flow of metal during forming, and Dr. Fuchs gave a very interesting and instructive presentation showing the influences of residual stresses on fatigue life of metals. Thirty-three were present.

Susquehanna Section Hears Talk on Tires for Service

On Dec. 9 in the Engineering Society of York auditorium, York, Pa., Frank F. Schippel of B. F. Goodrich Company, Akron, Ohio, talked on "Engineering Tires for Service." Mr. Schippel discussed the development and principal characteristics of synthetic rubber tires for automobiles, trucks, and war equipment. He illustrated the important points with charts and pictures in slide form. His talk was followed by a lively discussion on the merits of synthetic tires for passenger cars and trucks. Seventy-five were present.

A. P. Hickcox Speaks at Waterbury Section

On Nov. 26 at the University Club, Waterbury, Conn., Arthur P. Hickcox, vice-president, Scovill Manufacturing Company, gave a talk entitled "Analyzing Material Shortages." The speaker gave a very interesting analysis of some of the most outstanding shortages today, illustrating how some tied in together, and tracing them back to price controls, labor shortages, strikes, and other factors affecting raw-material production. In the discussion period following the talk Mr. Hickcox quoted statistics on today's economic condition of the country. Thirty-seven members and guests were in the audience.

Western Washington Section Holds Christmas Party

On Dec. 5 the Section held their annual Christmas party with the student branch of the University of Washington. It was a delightful get-together, attended by 36 Section members and 43 Branch members. Flowers decorated the tables, and Cragin and Company donated small steel screwdrivers as favors to those present. The Branch had charge of the program, although the Section too had a part in it. Prof. B. T. McMinn, member A.S.M.E., head of the mechanical-engineering department at the University, gave a short talk praising the Branch and Section relations and the faculty's wholehearted participation in A.S.M.E. Chairman Consley called on several Section members for short autobiographies to show the students the lines of endeavor A.S.M.E. members enter. Student chairman Decker took over the rest of the program. The student members, under the direction of program chairman Hoffman, presented a skit on performing a mechanical-engineering experiment. The evening's entertainment ended with a colored film of the University of Washington versus the University of Oregon football game of 1945.

Worcester Section Hears Prof. R. L. Peel

"Personnel Testing" was the subject at the Dec. 4 meeting in the Worcester Polytechnic Institute, Worcester, Mass. The speaker was Prof. Robert L. Peel, of Boston University. Professor Peel warned that personnel testing should not alone be used in hiring employees, but nevertheless it could save the employer money. "You check the performance of a $2500 machine pretty carefully before you buy it," he said, "but how carefully checked is a potential employee who might cause a concern a $2500 loss?" Twenty members and 20 guests were in the audience.

Books for Mechanical Engineers, 1946

THIS list of some important books of interest to mechanical engineers has been compiled for the convenience of A.S.M.E. members by the staff of the Engineering Societies Library. The books were selected from those added to the Library during 1946. Some equally good books may have been omitted but the desire for a short list has forced the Library staff to choose rather than to include all.

ELECTRONICS IN INDUSTRY. By G. M. Chute. 461 p. 1946. McGraw-Hill Book Co., N. Y. $5. Outlines the industrial uses of tube circuits and gives detailed explanation of a large number of electronic devices used.

AMERICAN MACHINISTS' HANDBOOK AND DICTIONARY OF SHOP TERMS. By F. H. Colvin and F. A. Stanley. Eighth edition. 1546 pp. 1945. McGraw-Hill Book Co., N. Y. $5. Standard reference work for the machinist, toolmaker, and designer of machine parts; provides a comprehensive collection of useful tables and data.

STEAM POWER PLANT AUXILIARIES AND ACCESSORIES. By T. Croft and D. J. Duffin. Second edition, 583 pp. 1946. McGraw-Hill Book Co., N. Y. $5. A practical manual for the operating engineer, revised to conform with the changes that have taken place in the 24 years since it was originally published.

GYROSCOPE AND ITS APPLICATIONS. By M. Davidson, editor. 256 pp. 1946. Hutchinson's Scientific and Technical Publications, London. 21s. Discusses general theory, types of gyroscopes, gyroscope problems concerned with the dynamics of the instrument, applications for marine and aeronautical purposes.

METALLIC CORROSION, PASSIVITY AND PROTECTION. By U. R. Evans. Revised edition. 863 pp. 1946. Longmans, Green & Co., N. Y. $14. Material in the new edition has been rearranged with considerable addition of recent developments.

DIESEL-ELECTRIC LOCOMOTIVE. By C. F. Foell and M. E. Thompson. 688 pp. 1946. Diesel Publications, N. Y. $7. Deals with the constructional, engineering, operational, and maintenance aspects of the subject. Also covers the history, development, advantages, and classification of Diesel-electric locomotives.

BEAMS ON ELASTIC FOUNDATION. By M. Hetényi. 255 pp. 1946. University of Michigan Press, Ann Arbor, Mich. $4.50. Deals with the analysis of elastically supported beams. Chiefly theoretical in nature, the book discusses as well the applications to a variety of problems in the fields of civil and mechanical engineering.

MARINE ENGINEERS' HANDBOOK. Prepared by a Staff of Specialists. J. M. Labberton, editor. 2013 pp. 1945. McGraw-Hill Book Co., N. Y. $7.50. Successor to Sterling's "Marine Engineers Handbook." An entirely new book.

FUNDAMENTAL THEORY OF SERVOMECHANISMS. By L. A. MacColl. 130 pp. 1945. D. Van Nostrand Co., N. Y. $2.25. The main concern is with the general theory which is applicable to all linear continuously operating servomechanisms and their essential identity with feedback amplifiers. Although some particular servomechanisms are discussed for illustration no attempt has been made to consider design details.

PERSONALITY AND ENGLISH IN TECHNICAL PERSONNEL. By P. B. McDonald. 424 pp. 1946. D. Van Nostrand Co., N. Y. $3.75. Emphasizes the importance of developing a definite personality, an accurate command of English, and effective methods for presenting ideas, both written and verbal, with specific suggestions for improvement in these particulars.

ENGINEER IN SOCIETY. By J. Mills. 196 pp. 1946. D. Van Nostrand Co., N. Y. $2.50. A group of essays, dealing with the relationship of scientists and engineers to the world society in which they function.

ELEMENTS OF AMMUNITION. By T. C. Ohart. 412 pp. 1946. John Wiley & Sons, Inc., N. Y. $6. Describes simply and thoroughly all types of ammunition as well as the main categories of small arms, artillery, aircraft, and rocket ammunition.

MATERIALS-HANDLING EQUIPMENT. By M. W. Potts. 172 pp. 1946. Pitman Publishing Corp., N. Y. $2.50. Describes and discusses the application of the standard types of materials-handling equipment.

ELEMENTARY MECHANICS OF FLUIDS. By H. Rouse. 376 pp. 1946. John Wiley & Sons, Inc., N. Y. $4. The author considers the mechanics of fluids to be as fundamental a treatment of fluid behavior as the mechanics of solids is of the behavior of rigid and elastic bodies, and develops flow principles from the basic equations of mechanics in a logical, systematic order.

RUBBER IN ENGINEERING. 267 pp. 1946. Chemical Publishing Co., Brooklyn, N. Y. $5.50. Gives a general survey of the information available on the theoretical aspects; provides useful information on rubber properties in practical use; deals with the principles of the design of rubber-engineering components.

APPLIED ENERGY CONVERSION, A TEXT IN POWER PLANT ENGINEERING. By B. G. A. Skrotzki and W. A. Vopat. 509 pp. 1945. McGraw-Hill Book Co., N. Y. $5. Explains the functions and operating principles of the major equipment used commercially in the conversion of energy. Follows the evolution of an operating central station and industrial plant from a combination of this equipment. Special developments in steam and power generation are considered also.

MATHEMATICAL THEORY OF ELASTICITY. By I. S. Sokolnikoff. 373 pp. 1946. McGraw-Hill Book Co., N. Y. $4.50. The first three chapters contain a comprehensive treatment of the underlying theory of the mechanics of deformable media. Chapter IV gives an up-to-date treatment of extension, torsion, and flexure of homogeneous beams. Chapter V contains a development of variational methods necessary for the treatment of problems of elasticity.

PHOTOGRAPHY IN ENGINEERING. By C. H. S. Tupholme. 276 pp. 1945. Faber & Faber, Ltd., 24 Russell Sq., London W.C.1. 42s. Discusses ways in which the camera is being used to simplify the draftsman's work, to analyze raw materials, to make records of high-speed machinery, in studying the molecular structure of metals, etc.

HIGH VACUUM TECHNIQUE, THEORY, PRACTICE, INDUSTRIAL APPLICATIONS AND PROPERTIES OF MATERIALS. By J. Yarwood. Second edition, revised. 140 pp. 1945. Chapman & Hall, Ltd., London. 12s 6d. Introduces the latest developments in apparatus, describes important industrial processes, and includes diverse facts regarding the relevant properties and uses of materials encountered in all types of vacuum work.

1946 E.C.R.A. Proceedings Available

PUBLICATION of the Proceedings of the 1946 annual meeting of the Engineering College Research Association has been announced.

Student Branches

University of Arkansas Branch

Two meetings were held in November in the Engineering Building. The first on Nov. 13, and the second on Nov. 27, presented interesting papers by members. W. O. Passarelli, Jr., gave the first paper entitled "Into Space," dealing with the latest on space ships and the possibility of a trip to the moon. Robert Paterson's paper on "Jet Engines" did a fine job in keeping the juniors and seniors abreast of this increasingly powerful heat engine. The published results of tests and facts on the German V-2 rocket was the subject of a paper given by Cage Cross, Jr. A complete outline of the rocket's operation, with illustrated diagrams, was displayed, and the guesswork of how this famous rocket works was removed from the minds of those present. W. D. Rowland gave a paper on "Air Conditioning," which made it quite evident that this field of engineering is only in its infancy. All these men were seniors, as it is the policy of this branch to have the seniors present their talks first. By doing this the juniors receive good ideas on how to best present engineering speeches.

POLYTECHNIC INSTITUTE OF BROOKLYN (DAY) STUDENT BRANCH LISTENS TO A TALK BY OTTO DE LORENZI, MEMBER A.S.M.E.

Polytechnic Institute of Brooklyn (Day) Branch

On Dec. 10, 1946, the sixth meeting of the year was held. Otto de Lorenzi, member A.S.M.E., Combustion Engineering Corporation, was the speaker, and gave a talk on "Stoker Design and Firing Methods." By the use of slides, the mechanisms and operating characteristics of the single retort, the multiretort, and the spreader-type stoker were shown. The single-retort stoker employed the use of bituminous coal which was forced in and up from the bottom of the fuel bed. As coke formed on top of the coal, the incoming coal broke up the formation and the coke, now ash, dropped off to one side. The multiretort stoker fed the coal onto a conveyer belt and was leveled off by a type of rake. Due to the slow movement of the conveyer anthracite coal is used. The ash which is formed is dropped off at the end of the conveyer. The spreader-type stoker uses either pulverized anthracite or bituminous coal. The coal is shot into the boiler and falls onto a conveyer and the action of combustion is carried on upon it. Mr. de Lorenzi then gave the audience a treat by showing actual stoker operation within boilers employing the afore-mentioned stokers. By means of speed-up technicolor moving pictures, long-time combustion periods were shown in the space of a few minutes. This type of picture is invaluable to the stoker designer as it provides the only accurate means of determining combustion conditions within a boiler. Ernest Hartford, executive assistant secretary, A.S.M.E., was the guest of honor, and he gave a few words of advice to the students concerning their future with the parent Society. Seventy-five were present.

Polytechnic Institute of Brooklyn (Evening) Branch

A meeting was held in room 135 on Nov. 25 with 60 members present. Professor McDuff, faculty member of the Institute, gave a lecture entitled "Machine Vibrations." He first gave a brief review of simple harmonic motion which he demonstrated by means of a working model, and then described the two types of transitory motion which are familiar to almost everyone; such as, earthquakes and wind forces. In actual practice, he said, there are fundamentally only three types of vibrations that the engineer must be able to understand and analyze. The first problem is in rotating machines; the second, the vibrating machine; and the third, the noise problem which is more pronounced because you hear actual results of vibrations. Professor McDuff gave the remedy for each, and closed his talk by stating that he did not use any mathematical conclusions to arrive at a solution, because, theoretically, it can be predicted what would happen to structures or machines under a load by just picturing what a person would do if one were a molecule being acted upon by an applied force or motion.

University of California Branch

A short business meeting was held on Nov. 7 in room 108, Engineering Building, conducted by Al Strong, vice-chairman. Resignation of the present chairman was reviewed and accepted and nominations for a new chairman were made.

At the meeting on Nov. 21, Don Welton was unanimously elected to fill the vacancy of chairman.

The new chairman presided at the meeting on Dec. 3, in room 104, Engineering Building. He introduced the speaker, C. W. Harper, chief engineer on the 40 ft × 80-ft wind tunnel at the Ames Laboratory. Mr. Harper spoke of the National Advisory Committee for Aeronautics, its development, present-day locations, and its functions. He mentioned that the N.A.C.A. had three main laboratories: The first, and "home" laboratory at Langley Field, Va.; the second, at Cleveland, Ohio, where a great deal of advancement on jet propulsion, rockets, etc., has been accomplished, and the third at the Ames laboratory at Moffatt Field, Calif. The speaker illustrated his lecture with slides showing the varied installations at Ames. The laboratory has a total of nine wind tunnels; their varied velocities range from common model velocities up through sonic, and into supersonic velocities. He showed a slide of the "pride" of the development, a 16-ft tunnel with pressure variation of from one sixth to six atmospheres. Mr. Harper told how the newly employed embryo engineer went through the various stages, advancing to the point of managing a complete experiment, writing it up, and seeing the results published.

Carnegie Institute of Technology Branch

On Dec. 4 the members were entertained with a technicolor movie entitled "Unfinished Rainbows," a feature-length picture on the history and development of aluminum. It graphically described the industrial processes which are employed in the production of aluminum and ended with a colorful demonstration of its uses.

Catholic University of America Branch

The meeting on Nov. 20 in the mechanical-engineering department, was called to order by the chairman, Richard L. Caslin. Plans for the season were discussed, and it was decided that the second Wednesday in each month would be the regular monthly meeting date for the Society. Chairman of committees were elected as follows: F. E. Dorsey, refreshment; J. E. Shea, program; H. M. Peden, membership. The program presented a talk by C. B. Harrison entitled "The History and Development of the Diesel Engine." This was followed by two films, "The Complete Assembly of the Allison Engine," and "The Fighting Lady."

Cornell University Branch

On Dec. 11 election of officers was held for the spring term. They are: E. S. Carlson, chairman; W. B. McNaughton, vice-chairman; and Miss S. Ogren, secretary-treasurer. Following the election, a film was shown entitled "Ideas for Work," made by the Higgins Boat Building Company. This film showed the methods of manufacture and performance of the various Higgins boats in peace and war.

University of Florida Branch

The meeting on Dec. 4 was called to order by chairman John Carpenter, who asked for suggestions on a new night on which to hold meetings. It was decided that the branch will meet every other Thursday in the Engineering Building, room 209. During the business meeting a committee composed of Messrs. Russell, Oliver, and Fox, was appointed to look into the possibility of the branch sponsoring a placement organization for graduates in mechanical engineering. The rest of the meeting was given over to the chairman for discussion of the function and organization of the A.S.M.E., for the benefit of the guests from the University College. Twenty-four were at the meeting.

Iowa State College Branch

The last meeting for the 1946 fall quarter was held on Dec. 5 in the Engineering Assembly. Robert Burgan, vice-chairman, acted in the absence of Richard Dove, president. After the business meeting an interesting film on the gas turbine, entitled "Tornado in a Box" was shown. One hundred and five were present.

University of Iowa Branch

The Nov. 20 meeting was called to order by

president L. E. Fuller, with 71 members present. Two movies constituted the program.

On Nov. 27 the meeting was held in the Engineering Building. The guest speaker was Leonard Mayer, a graduate of the 1943 class. Mr. Mayer gave a short synopsis of his work since he left school. Mr. Carr gave a talk on "Resinol Materials," and Mr. Clark spoke on "First Opposed-Piston Diesel Motor," designed by the Union Pacific. Seventy-one members were present.

In the Engineering Building on Dec. 4, Mr. Cropper gave a talk on "Nuclear Physics," and Mr. Dale spoke on "The Liquid-Propelled Motor." Sixty-nine members were in attendance.

The Dec. 11 meeting in the Engineering Building, was called to order by president L. E. Fuller, with 70 members attending. Mr. Dall gave a very interesting talk on the history of the engineering college at the State University of Iowa, and Professor Croft added several interesting remarks after the talk.

On Dec. 18 Professor Croft gave an interesting talk entitled "An Instrument of Peace." This was the theme of the UNESCO Conference to which he was a delegate. Seventy-two attended.

University of Maryland Branch

On Nov. 20 the program was a talk by Arthur H. Senner, member A.S.M.E., on the "Thermodynamics of the Gas-Turbine Cycle." Mr. Senner is superintendent of the gas-turbine project at the Naval Research Laboratory in Annapolis, Md. Of special interest was a description of the method of "wet compression" being utilized wherein water is injected into the air which is being compressed by the turbine compressor. This lowers the compression temperatures and decreases the work of compression with a consequent increase in over-all efficiency of the cycle. A film, "Tornado in a Box," was also shown. One hundred and thirty-three were present.

Montana State College Branch

At the Dec. 2 meeting in Roberts Hall it was announced that all seniors would be expected to make speeches on some technical subject starting with the winter quarter. These speeches are to be given at the meetings with the purpose in mind of selecting delegates to Oregon in the spring. A movie on dial gages was shown.

New York University (Evening School) Branch

On Nov. 19 a meeting was held in room 966, Waverly Building. A Riley stoker film entitled "The Construction of a Large Steam Generator," was shown, with comments by Robert Ellis, vice-chairman, employed by Combustion Engineering Company. The officers and program committee had decided to try the "forum" type of meeting, but owing to unforeseen circumstances, the audience at this meeting was small, and it was decided to dispense with a formal talk and discussion by a panel of students who work in that field. The informality of the meeting pleased the students, and they agreed that this type of meeting is much more stimulating to all concerned than the system of having a visiting lecturer give a fixed speech beyond the level of the audience's knowledge or interest.

University of Nevada Branch

On Nov. 26 a film "Tornado in a Box" was shown, through the courtesy of Allis-Chalmers Corporation, which dealt with the research and development of the gas turbine. An invitation was extended to the general public, and 20 members and 45 guests were present.

Ohio State University Branch

The meeting on Nov. 7 featured R. C. Blaylock, chief engineer, Curtiss-Wright Corporation, who spoke on "Recent Developments in Aeronautical Engineering." The speaker stressed the present and future possibilities of jet propulsion and gas turbines as used in aircraft.

On Nov. 21 in Robinson Laboratory, Prof. V. A. Ketchum gave a talk on "Speech for Engineers," in which he gave an example of a lawyer who is now head of one of the largest engineering companies in the United States at the present time. Professor Ketchum mentioned this man's interest in the study of effective speech and gave examples of his use of correct speech to "say things with the pertinence they demanded." After the meeting, the members present, numbering 91, had a group picture taken for publication in the "Makio," the Ohio State yearbook.

On Dec. 5 a meeting was held in Robinson Laboratory, at which the secretary reported the membership as 116. Three interesting talks were presented by student members: The first talk "Shop Work," was given by Roberts Lewis Last; the second, "Steam-Heated Airfields in the Pacific," was given by Damnon P. Swain, Jr., and the third, "Engineering Education," by Charles Emory Banner. The audience enjoyed the program.

Pennsylvania State College Branch

On the afternoons of Dec. 3 and 4 the branch visited the testing laboratories of the Pennsylvania Railroad in Altoona, Pa. The conducted tour was arranged by Prof. J. S. Doolittle, member A.S.M.E., associate professor of mechanical engineering at the College. Approximately 90 students were excused from classes for the tour. The inspection of the laboratories lasted from 2 to 5 p.m. and the tour was conducted by former graduates of Penn State which made it possible to correlate courses at the college with some of the tests. The tests themselves ranged from the testing of new materials to the physical examinations given employees. The outstanding feature was the tests that were in progress on a freight locomotive. The students had an opportunity to see large-scale operations of the latest testing devices, such as the oscillograph and automatic-graphing machines. The tests involving equipment that had failed in usage proved to be of unusual interest. The parts that had failed in service were brought to this laboratory. In many cases pieces of actual equipment such as rails and locomotive wheels were analyzed to determine the causes of structural failures.

Pratt Institute Branch

The annual "Grease Ball" sponsored by the branch, was held at the Institute on the evening of Nov. 23 in the mechanical laboratory. This affair had been traditional at Pratt prior to the war, and was revived for the first time since the war ended. Resounding to the music of Harry Arnold and his orchestra, scores of engineering students and their partners kept pace with the music. Appropriately, the background of the Grease Ball was that of steam engines, turbines, testing machinery, and the appropriate dress was worn by the guests, including cover-alls, slacks, dungarees, plaid shirts, etc. Faculty members and students alike came dressed for the occasion, and all had a very enjoyable evening.

TIME OUT AT THE ANNUAL "GREASE BALL" OF THE PRATT INSTITUTE STUDENT BRANCH HELD IN THE INSTITUTION'S MECHANICAL LABORATORY, NOV. 23, 1946

OFFICERS OF QUEEN'S UNIVERSITY STUDENT BRANCH

(*Left to right:* W. J. Sutherland, vice-chairman; A. B. Harris, chairman; Prof. H. G. Conn, honorary chairman; D. E. Millikin, secretary; and J. F. A. Smythe, treasurer.)

Purdue University Branch

The regular monthly meeting was held on Nov. 20 in the Electrical Engineering Building. Dr. John I. Yellott, member A.S.M.E., director of research, Locomotive Development Committee, Baltimore, Md., was the speaker. With the use of slides, Dr. Yellott carefully reviewed the reserves of fuel in the United States. He pointed out that coal is the logical fuel to burn because our supply was estimated to last 3000 years, while natural gas will last but 32 years, and petroleum, unless more is discovered, for only 15 years. Since coal is the fuel to burn and the coal-burning locomotive is so inefficient, a new method has to be found to use the fuel more efficiently. The research on the coal-burning gas turbine was started with the hope of getting an efficiency in range of the oil-burning locomotive. The slides showed the progress being made on the coal-burning gas turbine in the Committee's laboratories. His discussion included the difficulties encountered when trying to build the first coal-burning gas turbine and the solution to some of the problems. The officers of the branch were introduced to the new members. They are: Dr. C. F. Warner, junior member A.S.M.E., honorary chairman; Howard Eklind, chairman; Bob Eddy, Jim Fouts, Dave Copple, and Arnold Schnell, vice-chairmen; and Ted Ballin, secretary-treasurer. There were 230 present.

Queen's University Branch

Election of officers was held at two meetings in November, with the following results: Arthur Harris, chairman; Walter Sutherland, vice-chairman; Douglas Millikin, secretary; and John Smythe, treasurer. Prof. H. G. Conn, head of the department of mechanical engineering, was chosen honorary chairman.

On Dec. 12 a tour was made of the Kingston plant of the Canadian Shipbuilding and Engineering Company. Of special interest were the design department, the molding loft, outfitting, and graving-dock operations.

Rensselaer Polytechnic Institute Branch

On Dec. 12 the branch held a meeting in the Russell Sage Laboratory. The speaker was E. A. Winberg, chief engineer, Ludlow Valve Company, and an alumnus of the class of 1933, who discussed the developments of his company. Mr. Winberg covered such subjects as the wartime projects, among them the production of a 74-in. valve, new postwar valves, and their applications.

University of Rochester Branch

A regular meeting was held on Dec. 5, with John Mount, chairman, presiding. James Kinney discussed plans for a "discussion meeting" at a later date, with Carl Lauterbach, of Eastman Kodak Company, and R. Dewitt Pike of the Rochester Gas and Electric Company. The purpose of this coming meeting is to give the members a chance to find out the answers to problems they may have concerning employment after graduation. At the close of the meeting the group were invited to attend a meeting of the American Welding Society in room 208, Engineering Building.

University of Southern California Branch

On Nov. 7 in the Annex Building, room 120, Arthur Whistler, member A.S.M.E., consulting engineer, C. F. Braun and Company, Alhambra, Calif., spoke on "The Outlook for Future Engineers in the Field of Mechanical Engineering." Mr. Whistler advised the students how they should seek a position, the attitude they should have toward an employer, and the necessity of making a neat personal appearance during the interview. The speaker was enthusiastically received by the students, and many felt that this was one of the most interesting and practical meetings ever held. The attendance of 90 was greater than at any other meeting this semester.

On Nov. 22 a technicolor movie on theory, design, and construction of boilers, was shown through the courtesy of R. Meyler, a local representative of Riley Stoker Corporation. The theory of the boiler was presented in the picture by showing the flow of water and steam through a specially constructed glass boiler. A short business meeting was held and plans discussed for a joint meeting of the branch with the A.S.M.E. Southern California Section. The picture was shown for a second time on Nov. 26 for the benefit of students who could not attend on Nov. 22. Interest in the branch meetings is being created by colorful posters drawn by vice-chairman Robert Blumenthal, and displayed throughout the engineering college.

John W. Anderson, member A.S.M.E., formerly associated with the American Locomotive Company, and at present employed by Atlas Imperial Diesel Engine Company, Oakland, Calif., presented an interesting lecture on Diesel engines at the Dec. 5 meeting. Mr. Anderson traced the development of the Diesel engine from the time of Rudolf Diesel, and stressed the rapid advancement since the use of present type of fuel-injection system. He spoke authoritatively on Diesel installations all over the country, and answered the questions asked by students at the end of the lecture. Slides were shown of marine Diesel engines built by the Atlas Imperial Diesel Engine Company. After the lecture, E. Kent Springer, member A.S.M.E., honorary chairman, took Mr. Anderson on a tour through the mechanical-engineering laboratory.

A joint dinner meeting of the A.S.M.E.

MEMBERS OF THE STEVENS INSTITUTE OF TECHNOLOGY STUDENT BRANCH VISITING THE KEARNY PLANT OF THE WESTERN ELECTRIC COMPANY

(*Left to right:* Prof. K. J. Moser, member A.S.M.E., honorary chairman; Karl Kutz and Paul McDonnel, student members; W. Berthold, guide; Edward Lemke and Joseph Lynch, student members; Mr. Robinson, Western Electric Company; and James Hopper, student member.)

Southern California Section with the student branch was held on the campus of the University in the foyer of Town and Gown. The presiding officer at the meeting was Henry A. Hoste, chairman of the branch. The program was planned by the branch members who obtained Don Wilson, assistant chief engineer, Marquardt Engineering Company. Mr. Wilson spoke on "The Development of the Ram Jet Engine." The lecture was highly technical, although much information could not be revealed because of Navy restrictions. The Southern California Section showed a film "Bikini Atom Bomb Test," which was obtained by T. E. Colvin, member A.S.M.E., from the United States Navy Department. V. Peterson, of the Southern California Section, announced the date of the next meeting, and thanked the senior members for attending the joint meeting. Approximately 245 were present at the lecture and movie, and dinner was served to 195.

University of Tennessee Branch

A joint meeting of the branch with A.I.E.E., A.S.C.E., and A.I.Ch.E. branches, sponsored by the Associated Collegiate Engineers Board, was held on Nov. 21, with 66 present. It is planned to have four of these joint meetings in 1947, in the spirit of closer co-operation and joint activities of the branches. The program was planned by A.I.E.E., and Martin Winfrey, chairman of the Board, acted as chairman of the meeting. Dave Hatfield of the A.I.E.E. branch, introduced the speaker, J. L. Holton, engineer, Tennessee Eastman Corporation of New York, N. Y., who gave a talk on "Electrical Distribution in Greater New York City." The discussion of the layout, maintenance problems, and the load curves and generation requirements of the system proved very interesting. The question period following brought out many facts directly connected with course work.

On Dec. 5 in Estabrook Hall, the meeting was called to order by chairman J. C. Maxwell. The program consisted of two parts; the first, an advertising film on the Clark Equipment Company; this film showed the processes carried out on various Clark parts manufactured at the Michigan plants. The second part of the program was a talk by Prof. R. W. Morton, member A.S.M.E., on a trip to Watts Bar. Pictures of the location, various sections of the project, size, etc., were projected on the screen and discussed to give the students an idea of the important points to look for. The cost of building and operating the project was also discussed. A question period followed the talk.

An inspection trip was made to Watts Bar on Dec. 7. Forty students made the trip by automobile. The locks and lockhouse, situated on the east side of the river, were examined first. Then inspection of the dam was made; the spillways are located between locks and the powerhouse, and the spillway gates operated by an electric crane which travels on rails located on top of the dam. The members also viewed the screen house for condensing water for the steam plant located at the dam; the central-control station located above the dam on the west side of the river; the steam plant located about a half a mile below the dam; and finally, the hydroelectric plant.

Villanova College Branch

On Nov. 5 in Mendel Hall the second meeting of the current semester was held. James Murphy, chairman, opened the meeting with the announcement of the opportunity offered to the members of attending the Annual Meeting in New York. The program consisted of a technicolor sound motion picture entitled "There Is an Engineering Reason." This film, sponsored by the Yarnall Waring Company of Philadelphia, Pa., gave a very clear explanation of the various kinds of valves, gages, and safety devices used in connection with steam power plants. Forty were present.

On Dec. 18 twenty students visited the Westinghouse plant at Lester, Pa. The plant, located about seven miles from Philadelphia, manufactures steam power-plant necessities, such as turbines, condensers, feed pumps, etc. The first building inspected was that in which steam turbines were manufactured. There the students saw the drive shafts being turned on giant machines, the turbine blades being cut by the thousands, and the turbines being sent through the many stages of their assembly. A 105,000 kw turbine almost completed, was shown. It was very impressive, and its close tolerances a remarkable thing to realize. Next a tour was made through the condenser plant where condensers of varied design and size were viewed.

Virginia Polytechnic Institute Branch

At the Nov. 25 meeting three films were shown, i.e., "The Inside Story," produced by the Socony Vacuum Oil Company; "This Plastic Age;" and "Thrill Hunter," produced by the Dodge Division of the Chrysler Corporation. Eighty-eight were present.

Another meeting was held on Dec 2 at which E. R. Easton gave a talk on "A Job After Graduation," and C. W. Wood spoke on "The Development of the Liberty Ship." The president, Otey M. Glass, introduced these student speakers and gave details of their background.

At the Dec. 10 meeting William Goggs gave a short talk on "Turboelectric Drives for Oil Tankers," and H. M. Williams spoke on "What an Engineer Should Get From College." A field trip to the Norfolk and Western Railroad Shops, Roanoke, Va., was called off because of a coal strike.

Washington State College Branch

At the Dec. 12 meeting in room 3, Mechanical Arts Building, committees were appointed to work with the Associated Engineers in preparation for the Engineer's Ball to be held March 15. Bill Nasmyth was appointed to represent A.S.M.E., and will work with Vic Hughes, chairman of the committee for the Associated Engineers. Clifford Pfaffle was appointed to serve on the finance committee which will have charge of ticket sales and other problems of finance. The Engineer's Show, which is ordinarily held on a high school week end, will be conducted this year after a period of suspension during the war. The display will include various phases of engineering as presented by the respective departments. George Medley was appointed to be in charge of the mechanical engineer's display for A.S.M.E. Dean Ladd, branch treasurer, reported that there are now 46 members and he has set a goal of 50. Prof. F. W. Candee, member A.S.M.E., honorary chairman, announced that he, Dr. Pearl, and E. B. Parker, member A.S.M.E., attended the Inland Empire meeting of A.S.M.E. in Spokane recently, and that the organization is attempting to revive interest in the preparation and presentation of technical papers to be written on any engineering subject. Professor Candee suggested that the branch sponsor a contest, the winners of which would be entered in the A.S.M.E. contest to be held in May.

Washington University Branch

The officers of the branch for 1946-1947 are: W. Y. Leong, president; G. L. Palcheff, vice-president, secretary and treasurer. A new secretary and a new treasurer will be appointed in the near future.

The branch held their first meeting which was a smoker, in the auditorium, Brown Hall. Herbert Kuenzel, member A.S.M.E., professor of mechanical engineering, gave a short talk on the purpose of the A.S.M.E. The guest speaker was C. L. Zakh who worked for over a year with the Edo Aircraft Corporation, designing flying boats and floats. He spent seven years in China as technical adviser to the Commission on Aeronautical Affairs, in organizing and developing aircraft industry in China. Since his return to the United States in 1943, he has worked as chief engineer of helicopter and jet propulsion research division, McDonnell Aircraft Corporation. Mr. Zakh presented a short discussion on the XHJD-1 helicopter and its purpose. He augmented his talk with a short film on the first test flights made on the XHJD-1. He also presented some 20 slides of the different parts and sections of the XHJD-1, as well as a few slides on the tests which were run on the helicopter. There were 160 in the audience.

On Nov. 20 the guest speaker was O. C. Dunkin, sales manager of the replacement division, Sterling Aluminum Products Corporation. During the war he served as technical consultant for the Quartermaster Corps of the War Department. He spoke on "The Technical Aspects of Sales Engineering," and the high lights of his talk were: The increasing importance of sales engineering in the impending era of increased production; reasonable versus emotional selling methods; technique of selling technical goods. His talk was most interesting and enjoyed by the audience of 160 members and guests.

A.S.M.E. Sections

Coming Meetings

Anthracite-Lehigh Valley: February 28. Chamber of Commerce Building, Scranton, Pa., at 8:00 p.m. Subject: "The Gas Turbine—Present Developments and Future Prospects," by B. H. Van Dyke, manager, new products department, The Elliott Company.

Baltimore: February 7. Hotel Sheraton-Belvedere, Baltimore, Md., 7:00 p.m. to 1:00 a.m. This is the annual meeting to which

ladies are invited. This year student members from Johns Hopkins University and the University of Maryland are being encouraged to attend this dance and meet the members away from business.

Birmingham: February 24. Tutwiler Hotel, Birmingham, Ala., at 8:00 p.m. Subject: "Gas Turbine Locomotives," by John I. Yellott, director of research, Locomotive Development Committee, Baltimore, Md.

Cincinnati: February 6. Dean Herman Schneider Memorial (Engineering Societies Building); Dinner at 6:30 p.m., Meeting at 8:00 p.m. Subject: "Specific Study Pertaining to Tool Wear, Chip Characteristics, and Surface Finish of Free Cutting Steel," by G. P. Witteman, assistant metallurgical engineer, Bethlehem Steel Company, Inc., Bethlehem, Pa.

February 11. Taft Auditorium at 8:00 p.m. Twelfth Annual "Joint Council" Meeting. A.S.M.E. Cincinnati Section, will meet with eighteen other societies affiliated with the Technical and Scientific Societies Council of Cincinnati. Subject: "Some Postwar Applications of Wartime Development," by David Sarnoff, president, Radio Corporation of America.

Dayton: February 12. Engineers' Club of Dayton at 8:00 p.m. Joint Meeting with American Society for Metals and the American Society of Tool Engineers. Subject: "Recent Developments in Cutting Tools," by Hans Ernst, director of research, Cincinnati Milling Machine Company.

Kansas City: February 10. University Club at 6:30 p.m. Subject: "Steels for High Temperature Piping Systems," by J. J. Kanter, materials research engineer, The Crane Company, Chicago, Ill.

Metropolitan: Process Industries. February 5. 7:30 p.m., Room 502[1]—"Corrosion as Applied to All Types of Industrial Plants."

Materials Handling Forum. February 10. 7:30 p.m., Room 1101.[1] "How Some Materials Handling Problems Were Solved in the Burroughs Wellcome Company, U. S. A. Plant."

Metropolitan Section Night. February 11. 7:00 p.m.[1]—Hotel Capitol, Eighth Avenue at 51st Street.

Woman's Auxiliary. February 13. Room 1101.[1] Business Meeting at 1:30 p.m. Art Program at 2 p.m. Refreshments.

Machine Design. February 14. 7:30 p.m. Room 501B[1]—"Design and Application of Small Hydraulic Presses."

Joint Meeting, Fuels, Heat Transfer, Metals Engineering, and Steam Power Divisions. February 18. 7:30 p.m., Room 501[1]—"Non-Destructive Testing."

Industrial Instruments and Regulators. February 21. 7:30 p.m., Room 1101.[1] Seminar on "Relay Type or Intermittently Actuated Control Systems."

Forum. Feb. 25. 7:30 p.m., Room 502. "Opportunities for Engineers and Scientists in Government Service."

Petroleum. February 26. 7:30 p.m. Room 502.[1] Subject to be announced later.

New Haven: February 12. (Exact time and place will be sent out with an announcement). Subject: "New Developments in Welding," by Samuel L. Hoyt, Battelle Memorial Institute, Columbus, Ohio.

Philadelphia: February 12. Philadelphia Engineers Club, 1317 Spruce St., Philadelphia, Pa. Subject: "Aviation Gas Turbine Laboratory" (Speaker to be announced.)

February 18. Philadelphia Engineers Club, 1317 Spruce St., Philadelphia, Pa. Subject: "Oil and Gas Power."

February 25. Philadelphia Engineers Club, 1317 Spruce St., Philadelphia, Pa. Subject: "Management."

Providence: February 4. Joint Meeting with the Society for the Advancement of Management. Providence Engineering Society Building, 195 Angell St., Providence, R. I. Subject: "Work Simplification," by Allen H. Mogensen, management consultant, New York, N. Y.

Susquehanna: February 10. Joint Meeting sponsored by the Engineering Society of York, Pa.

Western Massachusetts: Hotel Sheraton, Springfield, Mass., at 6:30 p.m. Joint Meeting of Engineering Society of Western Massachusetts, and A.I.E.E. Springfield Section. Subject: "Silicones" (Speaker not yet announced.)

West Virginia: February 24. Daniel Boone Hotel, Charleston, W. Va., at 7:45 p.m. Subject: "Stars Above and Below," by Hans Ernst, research director, Cincinnati Milling Machine Company, Cincinnati, Ohio.

[1] Engineering Societies Building, 29 West 39th St., New York, N. Y.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative, nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

New York **8 West 40th St.**	**Chicago** **212 West Wacker Drive**	**Detroit** **109 Farnsworth Ave.**	**San Francisco** **57 Post Street**

MEN AVAILABLE[1]

CHIEF OR SENIOR INDUSTRIAL ENGINEER, experience includes time and methods study, job evaluation, layouts, tool design, and supervision of shop and engineering personnel; age 35, graduate mechanical, licensed, family; prefers Southeast. Me-142.

MECHANICAL ENGINEER, 27, married, 4 years' experience production engineering plus one year statistics and one year sales. Phi Beta Kappa. Presently employed but seeks connection suitable for ambitious young man. Me-143.

MECHANICAL ENGINEER. Aeronautical option, mechanical engineering graduate; ten years' experience; machine tools, aircraft components, including propellers and instruments; officer, air materiel command, engineering division, equipment laboratory in supervisory capacity. Desires connection in sales or development. Me-144.

RECENT GRADUATE, B.M.E., New York University; administrative and mechanical options. Desires supervised job in administrative engineering. Preliminary examination N. Y. State Professional Engineer passed; adaptable personality. Consider any location. Me-145.

MECHANICAL ENGINEER, single, 26, B.M.E., Cornell, 1943. Over three years' experience in research and development work on mechanical computers and testing rubber products. Location preferred, Northeast. Me-146.

CHIEF INDUSTRIAL ENGINEER OR ADMINISTRATIVE ASSISTANT; consulting industrial engineer, past five years; presently employed; age 29; experienced all phases of industrial engineering in diversified industries. Will travel or relocate. Me-147.

[1] All men listed hold some form of A.S.M.E. membership.

POSITIONS AVAILABLE

SALES ENGINEERS, 2, mechanical graduates, with ten years' experience. One to contact utilities, consulting engineers, and industrials in power field. The other to contact and sell industrial controls in the steel industry. $6000 year. Middle West. W-8285.

INSTRUCTORS, graduates, interested in teaching various phases of production management. Must have had five years' practical industrial experience, preferably in job evaluation, methods analysis, and time study, production or operating control, etc. Write giving details of education and experience. Upstate New York. W-8286.

POWER ENGINEER, capable of supervising the operation of a jute mill. Should have had ten to fifteen years' experience and be capable of modernizing and revamping power distribution system from the central power station to the various mills and living quarters in the mill compound. Must report single status on first contract. About $7000 year. India. W-8287.

MECHANICAL ENGINEER, young, to work on installation of new mill equipment for manufacturer of copper- and brass-mill products. Work will lead to production, operation, and maintenance. Should be familiar with brass mill or similar equipment. Position will lead to that of plant engineer. About $5000 year to start. Ohio. W-8294.

PLANT MANAGER, 35-40, graduate mechanical, to supervise plant maintenance. Must be amiliar with operations, etc. About $5000 year. Georgia. W-8301.

ENGINEERS, not over 35. (*a*) Designer who has had ten years' experience in the design of electric d-c motors. Knowledge of standardization, etc., necessary. Excellent opportunity. Also require man with experience on a-c motors. (*b*) Mechanical engineer experienced on the design of motors and generators. Must have some creative ability. Men with G.E. or Westinghouse experience, or railroad or elevator experience desirable. $5100-$5400 year. Northern New Jersey. W-8303.

ENGINEER OR PHYSICIST, to head up long-range fundamental research project in connection with instrumentation for guided-missile program. Permanent position with unlimited opportunity in expanding engineering firm. $6000-$7000 year. Virginia. W-8313.

INDUSTRIAL ENGINEER, 27-40, graduate, with five years' industrial experience, of which at least two were spent doing time-study work, using the same method as Ramond Associates, for development of production standards, methods analysis, investigations regarding plant layout, and servicing budgetary control and investigations. Some experience supervising installation of time standards or incentives desirable. About $6000 year. West Virginia. W-8316.

PLANT ENGINEER, preferably not over 35, with approximately five years' experience in process-plant maintenance. Salary open. Northern New Jersey. W-8332 (a).

ENGINEERS. (*a*) Development engineer to co-ordinate and follow all phases of an extensive gas-turbine engine development program, including tests of components such as compressors, combustion chambers, lubrication systems, fuel systems, etc., as well as complete engine tests. (*b*) Stress engineer with background covering strength of materials, stress analysis, and stress measurements, to set up a stress laboratory equipped to take stress measurements using brittle lacquer coatings, strain gages, and also photoelastic equipment. Ohio. W-8343.

DESIGN AND PROCESS ENGINEER, 35-45, mechanical graduate, with at least ten years' experience in design and development of production machinery, to design jigs, fixtures, and production machinery, for manufacture and assembly of electrical fittings and devices. $8000-$9000 year. Central New York. W-8349.

ASSOCIATE ENGINEER, mechanical, capable of eventually taking charge of mechanical-engineering division. Should have eight to ten years' experience in the design, construction, and operation of a modern steam-generating station, operating at 850 lb pressure, 900-degree steam. Will make extensive and important studies; supervise work of others; work on cost estimates and reports, etc. $5300-$6100 year. Massachusetts. W-8370.

INSTRUCTORS, ASSISTANT PROFESSORS, RESEARCH ASSOCIATES, to teach undergraduate mechanics plus some graduate work. Salaries: Instructors, $2150-$2650; assistant professors, $2850-$3600; research associates, $3800-$4800 year with one month's vacation. Virginia. W-8381.

PROJECT MANAGER, with fifteen to twenty years' experience in design of steam- and electric-generating plants for industrial installations and preferably one who has studied such problems from an economic standpoint. Should be familiar with all methods of firing, proper equipment, and other features of modern boiler plant, to supervise preparation of layouts and estimates, preparation of plans and specifications, contracts, purchase of equipment, etc. Pennsylvania. W-8386.

ENGINEER, mechanical graduate, 30-45, preferably with some design experience, to take charge of engineering department of expanding manufacturing concern. Work may include responsibility for research and development as well as supervision of over-all engineering and production methods. $6000-$10,000 year. Pennsylvania. W-8394.

PLANT ENGINEER, mechanical graduate, 30-40, with building- and equipment-maintenance experience, to supervise maintenance, equipment layout, and assist in production planning for package-goods manufacturer. $6000-$7200 year. Northern New Jersey. W-8406.

PLANT ENGINEER, 35-45, graduate, preferably with supervisory experience, for large manufacturer of small production equipment, generating portion of power requirements. Should have had building-construction and power-plant-operating experience. Permanent. Salary open—bonus and retirement-annuity participation. Write giving personal, education, and experience record. Middle West. W-8409-D.

MECHANICAL ENGINEER, who is an idea man, for research department working on experimental and development work in molecular stills, vacuum pumps, coating units, and other equipment. Must be able to conceive, present and otherwise follow through with ideas. Upstate New York. W-8428.

ELECTRICAL AND MECHANICAL DESIGN AND DEVELOPMENT ENGINEERS, college trained with three to eight years' experience in design and development of electromechanical equipment, electronic equipment or related fields. Research, development, and consulting work now under way include high-speed electronic computors, supersonic devices, jet propulsion, and special types of communications equipment. There will be opportunity to acquire common stock in the company to men whose work proves satisfactory and in this way, depending upon earnings income will be increased. Salaries for research engineers range from $4500 to $6000 per year. Salaries of supervisory engineers will be commensurate with their ability and experience. Positions are permanent and location at St. Paul, Minn. Interviews can be arranged at Washington, D. C., where an office of the company is also located. R-3852-C.

ENGINEERS, several, design and production problems involved in manufacture of fin and tube heat-exchange surface or steam-heating and ventilating products. Men to be project engineers for certain product groups. Northwestern Illinois. $300 to $400 per month and possibly more for especially well-qualified men. R-3933-C.

SENIOR ENGINEERS. (*a*) Servomechanisms, hydraulic, pneumatic, electric. (*b*) Gyromechanisms and other instrumentations. (*c*) General mechanical component design, airbourne radar. Several years' commercial experience in one or more of above, good educational background. Large guided-missile program. All phases, study, research, development, product design for production. Positions offer permanence, top salaries, and opportunities for increased responsibility for men who can produce. Massachusetts. B-1199.

DESIGNING ENGINEERS, Civil, electrical, and mechanical in all grades for plans and specifications of large sewage-disposal project. $350-$457 per month. Forty-hour week. Opportunity for advancement. San Francisco Bay area. S-412.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after Feb. 25, 1947, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Fellow, Member, Associate, or Junior

BAER, HARRY, Brooklyn, N. Y.
BARLOW, CARL N., Los Angeles, Calif.
BAUMHAUER, JOHN D., JR., Baton Rouge, La.
BEVAN, ROBY BEDELL, Houston, Texas
BIKOVSKY, ALEXANDER G., Bridgeport, Conn.
BIRK, G. W., Indianapolis, Ind.
BISHOP, EDWIN S., York, Pa.
BLACKBURN, GLENN S., Oak Ridge, Tenn.
BORNHOLDT, C. J., Euclid, Ohio
BOWER, WILLIAM S., Ridgewood, N. J. (Re)

Brown, Morris, Mattapan, Mass.
Brown, Virginius F., Detroit, Mich.
Bunker, Robert P., New Rochelle, N. Y.
Buss, John R., St. Louis, Mo. (Rt & T)
Cannity, Ernest, North Adams, Mass. (Rt)
Carr, Howard J., Fort Wayne, Ind.
Carson, Edward, Allston, Mass.
Cejtlin, U., Haifa, Palestine
Cermak, Josef Jan, Hradec Kralove, Czechoslovakia
Cole, Frank W., New York, N. Y.
Corliss, Earle, Wilmette, Ill.
Davidson, Philip L., Philadelphia, Pa. (Rt)
Denton, John E., Los Angeles, Calif.
Detrich, Robert Carl, Seattle, Wash.
Devol, Howard P., Alhambra, Calif.
De Young, John H., Deepwater, N. J. (Rt & T)
Dietrich, Erich W., Western Springs, Ill.
Ditzen, Edward C., Buffalo, N. Y.
Dixon, Maynard H., Troy, N. Y.
Dreissigacker, P. H., Jr., Ansonia, Conn.
Durham, Edwin, New York, N. Y. (Rt & T)
Duvekot, Theodore, Corning, N. Y.
Edgarton, Lewis S., Nantucket, Mass. (Rt)
Endlein, Carl, Atlanta, Ga. (Rt & T)
Feldman, Avner, New York, N. Y.
Ferrier, William John, Langhorne, Pa.
Fontana, Frank J., Long Beach, Calif.
Forse, H. Don, Anderson, Ind.
Gabrielli, G., Torino, Italy
Gaskell, Alfred S., Ames, Iowa
Gazley, Carl, Jr., Newark, Del.
Geissler, Carl A., Manchester, Conn.
Gerard, George, Bronx, N. Y.
Granbury, Herman, Shawmut, Ala.
Grieshaber, George W., San Francisco, Calif.
Griffith, William H., Columbus, Ohio
Grunau, Harry B., Canton, Ohio
Haarmann, Heinz A., West Reading, Pa.
Hamilton, Frank J., Hyde Park, Mass.
Hancock, John Edwards, Schenectady, N. Y.
Haynes, T. A., Wyandotte, Mich.
Hoard, Kenneth S., Cleveland, Ohio
Holford-Strevens, Lawrence St. G., London, England
Howe, Herbert E., Houston, Texas
Jacobson, J. E., Texas City, Texas
Kopecky, Josef J., Praha, Czechoslovakia
Kottas, Harry, Berea, Ohio
Kroostad, Robert W., Spring Lake, Mich.
Leafe, Russell P., Winchester, Mass. (Re)
Ledin, Carl W., West Roxbury, Mass.
Lipcon, Jules, Staten Island, N. Y.
Loiacono, Anthony J., Yonkers, N. Y.
Lurtey, W. A., Abington, Pa.
MacLean, Archibald, Jr., Philadelphia, Pa. (Rt)
Marroquin, Carlos F., Mexico, D. F. (Rt)
Marsh, Amos O., Jr., Salt Lake City, Utah.
Martin, Edward G., Boston, Mass.
Martin, H. Arthur, Kansas City, Mo. (Rt)
Martin, Randolph L. A., Lorain, Ohio
Massari, S. C., Chicago, Ill.
Masterson, William R., Salem, Mass.
Mattern, Frank G., Kenosha, Wis.
McAdams, W. H., Newton, Mass. (Rt)
McDaniel, Wayne S., Weehawken, N. J.
Meulengracht-Madsen, Per, New York, N. Y.
Mitchell, Robert W., Boston, Mass.
Mooar, D. L., Newton, Iowa
Morse, R. H., Jr., Chicago, Ill. (Rt)
Murphy, James S., Morgantown, W. Va.
Newmark, Nathan, Urbana, Ill.
Nordhielm, Berndt E., Peoria, Ill.
Orpin, Wallace B., Allston, Mass.
Overbeck, John E., Columbus, Ohio
Pryor, Knight, Louisville, Ky.
Rapp, Edward G., Willoughby, Ohio
Read, Charles M., West Newton, Mass.
Read, Granville M., Wilmington, Del.
Ritterspach, Blair, Dixon, Ill.
Robertson, Thomas A., Akron, Ohio
Robinson, Harold A., Elmhurst, N. Y. (Rt)
Rušinoff, Samuel E., Chicago, Ill. (Rt)
Rydman, Carl E., Worcester, Mass.
Sala, William E., Toledo, Ohio
Sanders, Fred, Binghamton, N. Y.
Schnell, Russell C., Salem, Oregon
Schonstedt, Erick O., Takoma Park, Md.
Scott, W. F., Newton, Iowa
Shafer, A. E. M., Allentown, Pa. (Rt & T)
Singh, Gopal, Lahore, India
Stine, Herbert G., Mount Vernon, N. Y.
Szewalski, Robert T., Washington, D. C.
Tepper, Sidney, New York, N. Y.
Thomas, Joseph E., Pittsburgh, Pa. (Rt)
Trent, Warren C., Stillwater, Okla.
Turnbull, Douglas C., Jr., Cockeysville P. O., Md. (Rt & T)
Turpin, Alexander J., Stewart Manor, N. Y.
Van der Pyl, Lyman M., Pittsburgh, Pa.
Washburn, Harold O., St. Paul, Minn. (Rt)
Wendel, William R., Allentown, Pa.
Weyhe, Arthur, New York, N. Y.
White, Edward M., Cape May Court House, N. J.
Wilterdink, Paul I., Cleveland, Ohio

CHANGE IN GRADING

Transfers to Fellow

Engle, Melvin D., Allentown, Pa.
Rabbitt, James A., New York, N. Y.
Raymond, Gwynne, Oklahoma City, Okla.

Transfers to Member

Brownell, Clifford E., Buffalo, N. Y.
Cohen, Robert, Lincoln, Nebraska
Dunn, Carroll H., Iowa City, Iowa
Gisonno, George, Brooklyn, N. Y.
Hernried, Erwin G., San Francisco, Calif.
Lewis, Herbert F., West Chester, Pa.
Lewis, William Dein, Phillipsburg, N. J.
Maine, William C., Amsterdam, N. Y.
Mulveny, Frank, Jr., Wilmington, Del.
Roehm, Jack M., Chicago, Ill.
Schoessow, Glen J., Barberton, Ohio
Shapiro, Ascher H., Cambridge, Mass.
Shreeve, Charles A., Jr., College Park, Md.
Stroud, Macon G., Wilmington, Del.
Treloar, James B., London, Ontario, Can.
Tucker, S. A., New York, N. Y.
Woods, Gordon K., Ypsilanti, Mich.

Transfers from Student Member to Junior.... 50

A.S.M.E. Members Contribute to I.S.A. Meeting

A.S.M.E. members contributed several papers to the fifteenth annual meeting of the Institute of the Aeronautical Sciences held at the Hotel Astor, New York, N. Y., Jan. 27 to 30, 1947.

Joseph H. Keenan, member A.S.M.E., and Joseph Kaye, junior member A.S.M.E., both of the department of mechanical engineering, Massachusetts Institute of Technology, presented a paper on "A Survey of the Calculated Performance of Jet Power Plants."

Hugh L. Dryden, member A.S.M.E., director, National Bureau of Science, was co-author of a paper on "The Use of Damping Screens for the Reduction of Wind-Tunnel Turbulence," which was read at the aerodynamics session.

Igor I. Sikorsky, fellow A.S.M.E., Sikorsky Aircraft Division, United Aircraft Corporation spoke on "Notes on Helicopter Development."

Necrology

It is urged that the Society be notified promptly of the deaths of members and that the date of death be given for announcement in Mechanical Engineering. Complete memorial biographies are published in the Society Records (Section Two of Transactions), and relatives, business associates, and Society officers and members are requested to send newspaper clippings or information in any other form which will be useful in the preparation of such biographies. A special biographical data sheet for supplying complete details will be furnished upon request.

Bliss, Collins P., December 27, 1946
Budd, Edward G., November 30, 1946
Davey, George W., July 17, 1946
Erskine, James H., August 18, 1946
Franzen, Carl J., August 16, 1946
Gangwere, Elliott D., July 3, 1946
Hepke, William C., October 2, 1946
Inglee, Clinton, December 21, 1946
Kelley, Robert T., March 3, 1946
Kincade, Elmer C., March 5, 1946
Kroto, George, December 12, 1946
Peterson, Arvid, December 19, 1946
Schaefer, C. T., October 7, 1946
Scoville, James D., November 15, 1946
Simeon, Charles J., November 2, 1946
Snyder, Harry E., December 26, 1946
Spicknell, Charles E., October 20, 1946
Stewart, John T., June 29, 1946

A.S.M.E. Transactions for January, 1947

The January, 1947, issue of the Transactions of the A.S.M.E. contains:

Symposium on Development of Emergency Power Plants for Tanks
- Chrysler Multibank Power Plant for Medium Tanks, by H. T. Woolson
- General Motors Two-Cycle Diesel Engines for Ordnance Vehicles, by F. G. Shoemaker
- Designing and Developing Ford Engines for Medium and Heavy Tanks, by P. H. Ponts
- Cadillac Twin V-8 Power Plant for Light Tanks, by J. F. Gordon

Steam-Air Jets for Abatement of Locomotive Smoke, by E. D. Benton and R. B. Engdahl
Unified Symbolism for Regulatory Controls, by G. A. Philbrick
Application of Steam-Jet Ejectors in the Houdry Fixed-Bed Catalytic Cracking Process, by Philip Freneau, George Kelso, and A. W. Hoge